Schlumberger

Exmouth SLB15 MC3D MSS

ENVIRONMENT PLAN SUMMARY

September 2016

Rev 1

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1 Description of the Activity

1.1 Overview of the Activity

Schlumberger Australia Pty Ltd (SLB) proposes to acquire a multi-client, three dimensional (MC3D), marine seismic survey (MSS) in Commonwealth waters of the North West Shelf (NWS) off northern Western Australia (WA). Herein the program is referred to as the Exmouth SLB15 MC3D MSS. The activity (seismic data acquisition) will run from September 2016 to September 2018. The activity will not be continuous during this period and allowances have been made for the possibility that the survey may be interrupted (i.e. for commercial, weather, environmental or other reasons). The activity will be completed by the end of September 2018.

The permit areas in which the activity is planned to occur lie within Commonwealth waters and exploration activities in these waters are subject to the Offshore Petroleum and Greenhouse Gas Storage Act 2006 (OPGGS Act) and the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS(E) Regulations).

A single, purpose-built seismic survey vessel will be used unless undershooting is required. If undershooting, a second vessel will tow the seismic airgun array.

The seismic survey vessel will traverse a series of pre-determined survey lines or 'sail lines' within the operational area, at a speed of approximately 4-5 knots (8-9 km per hour) during data acquisition. The MSS acquisition is planned for 24 hours per day for the duration of the activity.

As the vessel traverses the sail lines, a series of acoustic pulses will be discharged every 8-10 seconds from dual airgun arrays of approximately 3,147 in^3. The acoustic pulses will travel through the water column and into sub-seabed rock formations. The sound waves will be reflected from buried rock layers and recorded on hydrophones carried by up to 12 towed 'streamers' up to 8 km long. The seismic data will be analysed to assess the subsurface geology for potential oil and gas reservoirs.

Activities conducted within the operational area include: acoustic emissions ramp-up for 'soft start', acoustic emissions on sail lines, miscellaneous maintenance operations, refuelling and vessel turns at the end of each sail line.

Support vessels will be used to assist with managing interactions with other marine users and marine fauna. All vessels will run on marine gas oil and will be refuelled offshore.

Helicopters may also be used to transport equipment, supplies and crew to the operational area during the Exmouth SLB15 MC3D MSS; and also to provide emergency medical evacuation if required.

1.2 Location

At its closest points, the operational area lies 13.3 km north of North West Cape, 5.8 km north-west of the Muiron Islands and at least 3 km north of the Ningaloo World Heritage Area. The operational area is shown in Figure 1 and the coordinates are presented in Table 1.

The operational area is approximately 35,210 km^2 (coordinates below). Seismic data acquisition is wholly contained within the operational area.

Petroleum Titles within the operational area are presented below in Figure 1 and Table 2. A summary of petroleum operators with interests in the operational area is provided in Table 14.

Table 1: Operational area (coordinates, WGS84)

Longitude (Decimal Degrees)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Latitude (Decimal Degrees)
114.384840	-21.570360	113.001970	-21.334600
114.360360	-21.576900	113.582090	-20.495890
114.350060	-21.582250	113.584420	-19.999200
114.338830	-21.589460	113.915250	-19.583110
114.327990	-21.598910	115.093840	-19.669820
114.320370	-21.607990	114.946400	-20.497340
114.312880	-21.617810	114.946910	-20.977230
114.304590	-21.624280	114.897660	-20.977670
114.296030	-21.632110	114.896510	-21.082030
114.284130	-21.642050	114.788660	-21.081900
114.270760	-21.653120	114.751300	-21.248710
114.251310	-21.665380	114.725150	-21.480400
114.084640	-21.665380	114.546510	-21.532970
114.001310	-21.665380	114.473990	-21.551350
113.031060	-21.665210	114.414840	-21.564700
112.999640	-21.500160		

Table 2: Petroleum titles within the operational area

WA-005-R	WA-035-L	WA-155-P	WA-427-P
WA-010-L	WA-036-L	WA-205-P	WA-428-P
WA-012-L	WA-036-R	WA-214-P	WA-430-P
WA-013-L	WA-037-L	WA-253-P	WA-444-P
WA-014-R	WA-038-L	WA-255-P	WA-450-P
WA-015-R	WA-039-L	WA-268-P	WA-461-P
WA-019-R	WA-040-L	WA-271-P	WA-463-P
WA-020-R	WA-041-R	WA-290-P	WA-474-P
WA-021-R	WA-042-L	WA-320-P	WA-475-P
WA-022-L	WA-042-R	WA-335-P	WA-476-P
WA-022-R	WA-043-L	WA-350-P	WA-478-P
WA-023-R	WA-045-L	WA-351-P	WA-483-P
WA-024-R	WA-049-L	WA-358-P	WA-486-P
WA-025-L	WA-049-R	WA-367-P	WA-497-P
WA-028-L	WA-050-R	WA-374-P	WA-500-P
WA-031-SPA	WA-053-R	WA-383-P	WA-511-P
WA-032-L	WA-055-L	WA-390-P	WA-516-P
WA-032-SPA	WA-074-AA	WA-392-P	WA-520-P

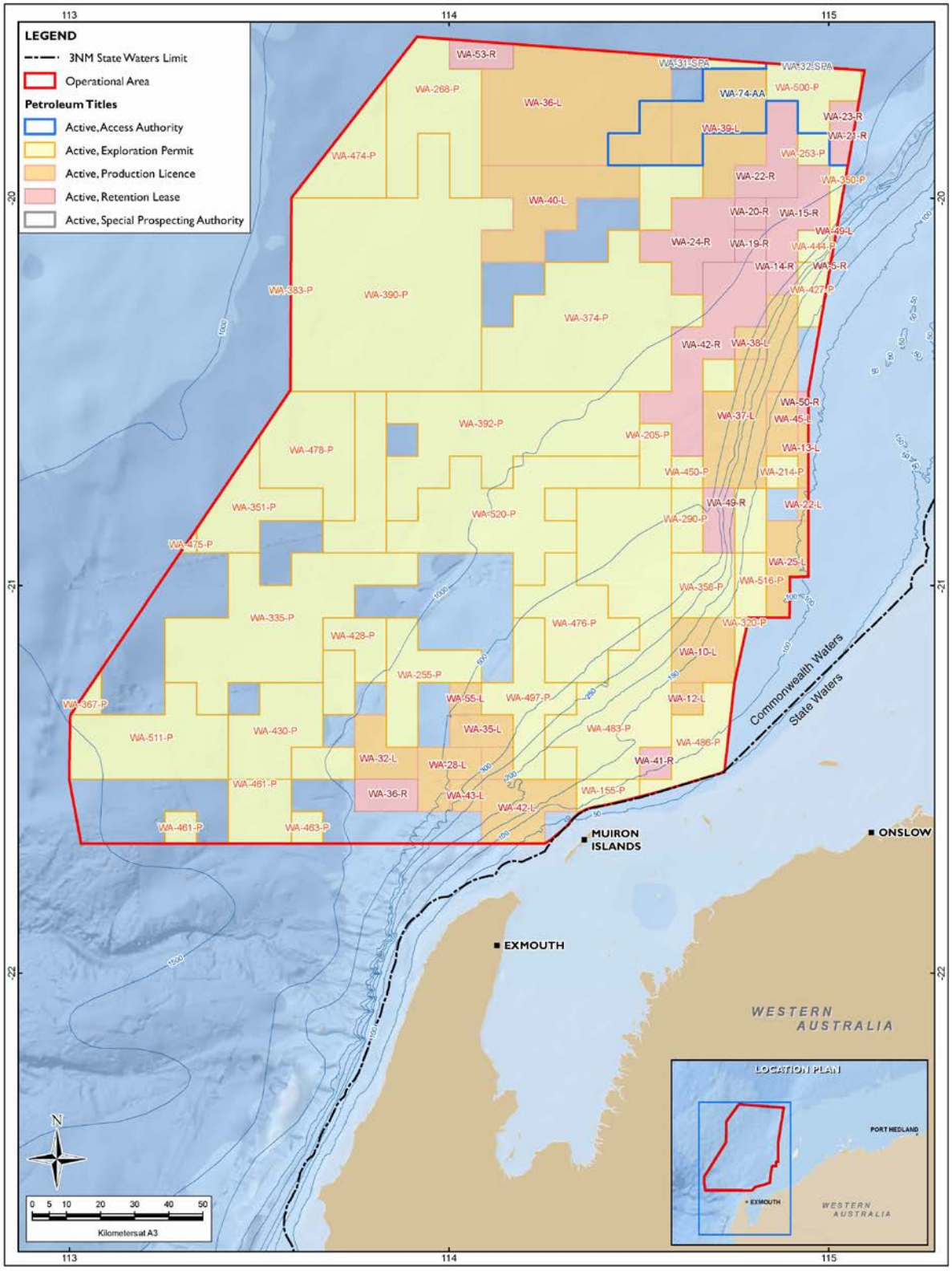


Figure 1: Location of operational area and relevant petroleum titles

1.3 Activity Design Characteristics Relevant to Environmental Management

The activity has incorporated a number of characteristics into the design of the survey that contribute to eliminating, reducing and mitigating potential impacts and risks, and which have been incorporated into the control measures for the activity presented in Section 4. These measures are summarised below:

- Seismic source
  - SLB will consider the use of 'e-source' array if available and assess its ability to meet the survey objectives and the likely reduction in environment risk.
  - SLB will use in-streamer hydrophones to verify the power output of the sound source, and if technically robust will use this for adaptive management (such as revising buffers and low power and shut-down zones).
  - The seismic source will only be discharged if an observed turtle is >350 m from the source, or has not been seen for 15 minutes.
- Activity timing
  - SLB will endeavour to commence survey no earlier than November 2016 and to complete all seismic data acquisition prior to July 2017. This will avoid overlap with the critical period for migrating and aggregating humpback whales in the Exmouth area. If survey cannot be completed by July 2017, additional mitigation measures will be implemented; namely increasing the pre-start observation period, extending the observation zone, extending the low power zone and extending the shutdown zone; during the peak humpback whale migration period (July – September)
- Activity location
  - Seasonal exclusion zone plan shown in Figure 2 will be implemented to confer additional spatial and temporal separation between survey vessel and migrating whales and whale sharks:
    - Area 1: Northern area without temporal restrictions
    - Area 2: Middle area, Acquisition only during December – April
    - Area 3: Southern area, Acquisition only during January – February.
  - SLB will maintain a 500 m buffer between the airguns and the listed protected and significant areas adjacent to the operational area (with the exception of the Gascoyne multiple use zone).
  - The seismic vessel or activities will not enter the Ningaloo World Heritage Area (unless in the event of an emergency).
  - The seismic survey vessel will not enter into shallow waters <30 m water depth (unless in the event of an emergency).
- EPBC Policy Statement 2.1 management measures will be implemented as summarised below (refer to Section 4.4.3 for full details of all Part A and Part B measures that will be implemented).
  - The precaution zones for the survey are based on a precautionary approach and are:
    - observation zone: 3+ km horizontal radius from the acoustic source;
    - low power zone: 2 km horizontal radius from the acoustic source; and
    - shut-down zone: 500 m horizontal radius from the acoustic source.
  - Pre-start-up visual observations for whales and whale sharks undertaken in the observation zone by MFOs for 30 minutes prior to commencement of soft start procedures
  - Increase pre-start observation time to 45 minutes, observation zone to 4 km, low power zone to 3 km and shutdown zone to 1 km during peak whale and whale shark migration periods (collectively March to December).
  - Increase pre-start observation time to 45 minutes, observation zone to 4 km, low power zone to 3 km and shutdown zone to 1 km when the seismic vessel is operating the acoustic source within the Seasonal Exclusion Zone Area 3 (January and February).
  - In the event that there have been more than three whale or whale shark instigated shut-downs in the preceding 24 hours and the seismic vessel CANNOT move away from the current area to a new area, the pre-start observation time will be increased to 45 minutes, observation zone to 4 km, low power zone to 3 km and shutdown zone to 1 km.

- Soft start procedures: may only commence if no whales or whale sharks have been sighted within the low power or shutdown zone during the pre-start-up visual observations. Soft start procedures will be used each time the acoustic source is initiated; gradually increasing power over a 30-minute period.
- If the whale or whale shark enters the low power zone the source will be powered down to the lowest setting; and if it enters the shut-down zone the acoustic source will be shut down completely.
- Following a shut-down, soft start procedures will only commence after the whale or whale shark has moved outside the low power zone, or when 30 minutes have elapsed since the last sighting.
- The seismic vessel will be relocated following a shutdown, if greater than 20 whales are observed in the observation zone during the pre-start observation, but not close enough to prevent soft-start commencing (i.e. outside low power zone).
- Shut-down or power down the acoustic source to the lowest setting when not collecting data, or undertaking soft start procedures (e.g. during line turns or when moving to another part of the Operational Area).
- Two MFOs will observe whales and whale sharks during all seismic survey activities conducted in daylight hours.
- A third MFO will be stationed on the scout vessel (as required) during the whale shark aggregation and migration periods (March to November).
- Passive Acoustic Monitoring (PAM) will be implemented on the seismic vessel at night and during periods of poor visibility by a trained and experienced PAM operator when the acoustic source is operational.
- During daylight hours PAM detections will be validated against MFO observations and ranges, in order to determine the error (if any) in PAM detection distances.
- If PAM records are shown to be inaccurate in estimating distances, the seismic vessel will power-down in the event of a confirmed detection (comprising 3 or more detection records for an individual whale) and not power-up until 30 minutes has passed without another detection.
- SLB or the seismic Vessel Master will liaise with Exmouth-based tourism operators (Norwest Air Work) with active spotter planes and request notification of whale or whale shark presence when seismic survey operations are underway.

- Adaptive management measures to avoid disturbing aggregations of whales, whale sharks or turtles may include:
  - reducing vessel speed, changing course, reducing airgun power, moving to an alternative sail-line or shutting down the airguns if necessary.
- Adaptive management measures to avoid or minimise conflicts with fishers (commercial and charter) will include:
  - moving to another sail-line, deviating around fishing activity area by 3 km, allowing fishers to fish area prior to seismic acquisition, or minimising survey activity in areas where there is known fishing activity.

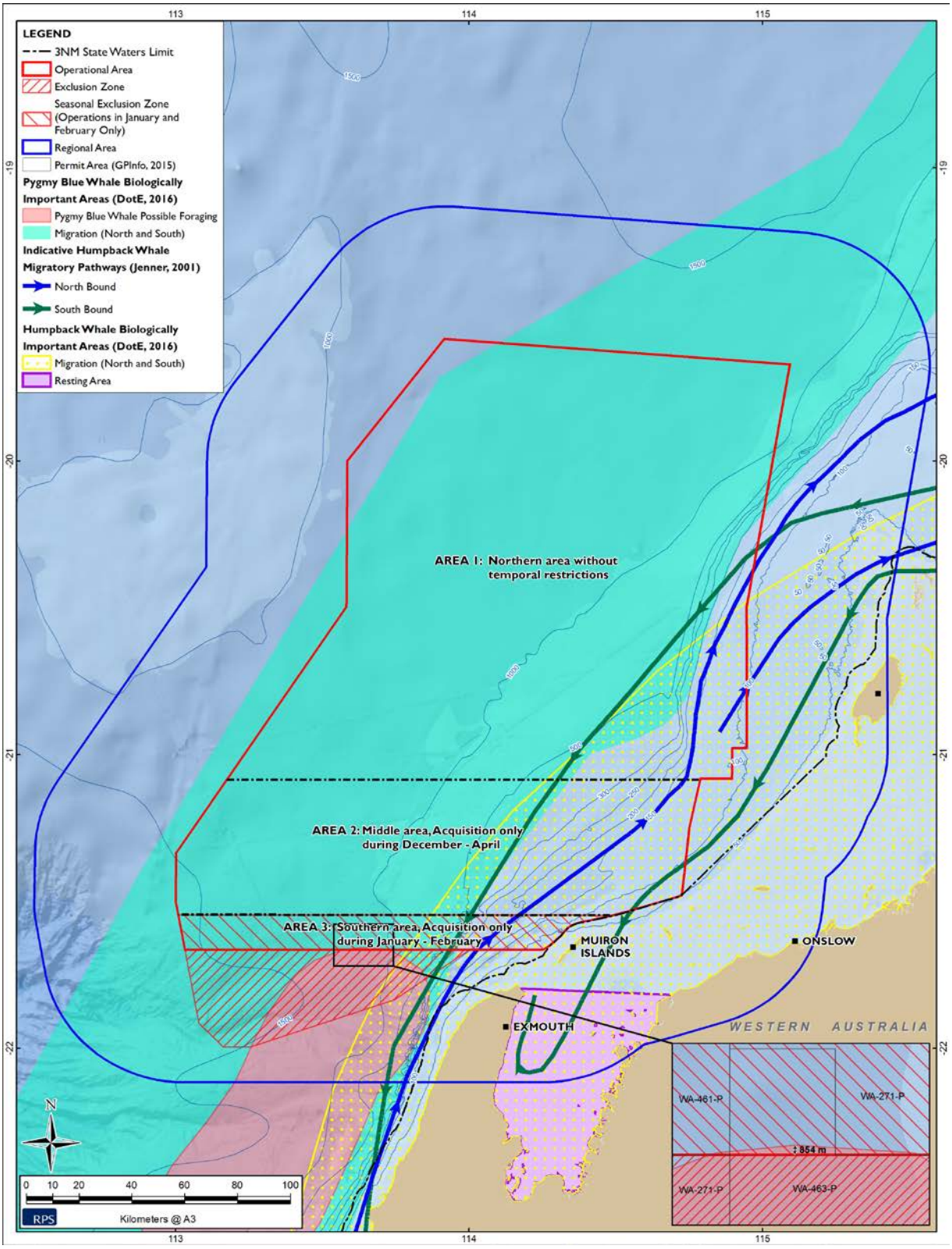


Figure 2: Seasonal Activity Exclusion Zones

2 Description of the Environment

The following section provides a description of the environmental, social, economic and cultural features that may be directly or indirectly affected by the activity. Values and sensitivities to impact are further described in Section 2.8. The regional area encompasses the area where impacts may be observed during an oil spill emergency.

2.1 Physical environment

A summary of key physical features within the regional area is provided in Table 3.

Table 3: Summary of physical environment

Aspect/feature	Description
Oceanography and meteorology within the regional area	
Regional influences of the NWSA	Dominant influences are ocean currents, tides, seasonal wind flows and bathymetry. Cyclones may also occur in the region. Currents on the inner continental shelf are driven by the tide and prevailing winds, with increasing influence by the prevailing ocean currents towards the outer shelf and slope (Condie *et al*. 2006). The bathymetry of the continental shelf slope also influences the oceanography of the area. The net current direction at inner continental shelf is largely influenced by the prevailing winds and the resultant direction of currents is to the north north-east in summer and south south-west in winter (Chevron Australia 2010). Speeds are described below.
Bathymetry	Bathymetry ranges from 30 m – 1,500 m depths within operational area. Depths reflect the locations relative to nearshore islands through to offshore canyons. The seabed bathymetry affects currents close to shore where it funnels and speeds water around the tip of the North West Cape (NWC), pushes water along parallel to the islands between Muiron Islands and Barrow Island and speeds currents around the north of the Barrow Island and Montebello Island chain (Chevron Australia 2010). In addition, a number of bathymetric key ecological features (KEFs) occur in the region (refer to Section **2.8**).
Climate[1]	Winter (dry season) May to September (12°C to 27°C) Summer (wet season) October to April (21°C to 37°C)
Water temperature	Summer sea surface: avg. temperature 23°C Winter sea surface: avg. temperature 21°C
Wind[1]	Summer: avg. 20-30 km/hr., gusting above 30 km/hr. 10% of the time (dominant direction south-westerly) Winter: 10-25 km/hr., gusting above 30 km/hr. 20% of the time (dominant direction south-easterly)
Waves	Avg. <1 m height, and <2 m peak
Tides	Strong semi-diurnal tides (four per day) (Holloway & Nye 1985). Tidal range: approximately 4 m Tidal current speeds of 0.25 knots during neap tides and up to 0.5 knots during spring (NSR 1995). Peak tidal flows are to the east on the flood, and to the west on the ebb (Holloway & Nye 1985).
Currents	Dominant currents are the Indonesian Throughflow and Leeuwin Current. The Leeuwin Current carries warm tropical water south along the edge of WA's continental shelf, reaching peak flow

Aspect/feature	Description
	in winter and becoming weaker in summer due to the strong prevailing opposing winds (Feng *et al*. 2009). The current is narrow (approximately 30 km wide), and occurs at the surface, extending in depth to approximately 300 m (Godfrey & Ridgway 1985). The Indonesian Throughflow is the influencing current that drives the Leeuwin Current south (Godfrey & Ridgway 1985, Feng *et al*. 2003). This current brings warm and relatively fresh water to the region from the western Pacific via the Indonesian Archipelago.
Cyclones[1]	Originate from the north and east during summer (October to April) Onslow is the most cyclone prone area on the NWS. For example, a category 1 (90 km/hr winds) hits once every 2 years on average.
Geology	
Regional geology[2]	Limestone, sandstone and sandy seafloor that support coral reefs, sessile invertebrates and seagrass and algae beds respectively. Terrigenous sediments also occur, which helps to support mangroves. Seafloor sediments: Sand and gravel on shelf Mud on slope and abyssal plain Main constituent: Calcium carbonate Other: Terrigenous sediments (minor) on inner shelf close to river mouths

[1] *BOM 2015* [2] *Falkner et al. 2009*

2.2 Key ecosystems

The operational area includes water depths <50m depth (south-eastern extent adjacent Muiron Islands). There are no known significant benthic features such as coral reefs or hard strata outcrops within this area. There is a possibility of isolated sparse seagrasses. Approximately 48 km^2 of the operational area is in water depths of 30-50 m, and of this area <8 km^2 is less than 40 m deep.

A summary of key features within the operational area (OA) and regional area (RA) is provided in Table 4.

Table 4: Summary of significant ecosystems

Aspect/feature	Summary of key aspect/feature	OA	RA
Benthic Habitats			
Coral reefs and shoals	Coral reef communities in the region are primarily located in shallow, rocky areas along and off the Pilbara coast. Significant regional coral habitats include the reefs of the Barrow Island – Montebello Island group, the Muiron Islands and the 260 km long fringing reef of Ningaloo adjacent to the NWC. These coral reefs provide essential habitat for fish, crustaceans, sponges and molluscs (Spalding *et al*. 2001). Significant coral spawning occurs at all sites in autumn (March/April), and some taxa such as *Acropora* spp. may spawn in spring (October/November) and summer (Rosser & Gilmour 2008).	-	✓
Seagrass	Seagrasses are important primary producers in tropical inshore waters as they provide energy and nutrients for detrital grazing food webs. They are also directly grazed by protected animals such as dugongs and green turtles, and provide refuge areas for fishes and invertebrates (DEC 2006). Seagrasses usually grow on mud, sand or coral sand from the intertidal zone to approximately 50 m water depth, and are most prolific in 2 m to 10 m depth. They can be found adjacent to offshore islands, including those of the Muiron Islands and Barrow Island as well as in Exmouth Gulf (CALM	-	✓

Aspect/feature	Summary of key aspect/feature	OA	RA
	& MPRA 2005; DEC 2006).		
Macroalgae	Macroalgae are most prolific over shallow areas of the region (< 25 m) where sufficient light is available for photosynthesis, particularly where hard substrates occur on which they attach. Macroalgae are important primary producers and support diverse and abundant fauna of small invertebrates that are the principal food source for many inshore fish species. They are patchily distributed on the Ningaloo Reef and Muiron Islands, however they are recognised as an important primary producer within the Marine Parks (DEC 2007).	-	✓
Soft sediments	Unconsolidated sediments support benthic fauna living both in the sediments (infauna) and on the surface (epifauna) as well as seagrass. Predominant infauna species are mobile burrowing species including molluscs, crustaceans (crabs, shrimps and smaller related species), polychaetes, sipunculid and platyhelminth worms, asteroids (sea stars), echinoids (sea urchins) and other small animals. Surface species include small crustaceans and molluscs, echinoderms and larger sessile organisms such as sponges, corals, sea whips and sea squirt (DEC 2006). Soft sediment habitats that support infauna are widespread in deeper offshore areas and in more protected inshore environments throughout the region (CALM & MPRA 2005; DEC 2006).	✓	✓
Shoreline habitats			
Mangroves	Mangroves are recognised as significant as they are productive coastal forest systems, providing habitat and shelter for birds, fish and other marine species and breeding sites for juvenile fish, lobster and prawns (EPA 2001). They are also recognised for their capacity to help protect coastal areas from the damaging effects of erosion during storms and storm surge. Significant mangrove habitats in the regional area include areas on the eastern coast of the Exmouth Gulf (EPA 2001).	n/a	✓
Intertidal mud and sand flats	Intertidal beaches and mudflats in the region host a range of infauna, including molluscs and polychaetes that are an important food source for wading birds. Sandy intertidal beaches/mudflats throughout the region are typically important habitats for nesting turtles and seabirds (DEC 2007).	n/a	✓
Sandy beaches	Sandy beaches provide habitat for a variety of burrowing invertebrates and subsequently provide foraging areas for shorebirds. They are recognised as important habitat for turtle nesting and breeding, particularly at Barrow Island, Muiron Islands, Ningaloo Coast (DEC 2007).	n/a	✓
Rocky shorelines and intertidal platforms	Rocky shoreline formations offer habitat to a range of intertidal species including invertebrates, and some shoreline birds, and are an important foraging area for seabirds. Rocky shorelines are found across the region and are often indicative of high energy areas (wave action) where sand deposition is limited or restricted. Intertidal habitats support a diverse assemblage of vertebrates and invertebrates particularly in vegetated areas. Intertidal platforms can support extensive macroalgal communities with varying degrees of faunal diversity, including sponges, ascidians and soft corals (Chevron Australia 2010).	n/a	✓

2.3 Threatened Species and Migratory Fauna

A summary of threatened and migratory species within the operational area and regional area protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is provided in Table 5.

Table 5: Threatened and migratory species identified in EPBC Act Protected Matters Search

Species name	Common name	EPBC Act status	Operational area	Regional area
Marine mammals				
Balaenoptera musculus	Blue whale	Endangered and migratory	Migration route known to occur within area	Migration route known to occur within area
Eubalaena australis	Southern right whale	Endangered and migratory	Species or species habitat likely to occur within area	Species or species habitat likely to occur within area
Megaptera novaeangliae	Humpback whale	Vulnerable and migratory	Congregation or aggregation known to occur within area	Congregation or aggregation known to occur within area
Balaenoptera bonaerensis	Antarctic minke whale, dark-shoulder minke whale	Migratory	Species or species habitat may occur within area	Species or species habitat may occur within area
Balaenoptera edeni	Bryde's whale	Migratory	Species or species habitat may occur within area	Species or species habitat may occur within area
Orcinus orca	Killer whale, orca	Migratory	Species or species habitat may occur within area	Species or species habitat may occur within area
Physeter macrocephalus	Sperm whale	Migratory	Species or species habitat may occur within area	Species or species habitat may occur within area
Sousa chinensis	Indo-Pacific humpback dolphin	Migratory	Species or species habitat may occur within area	Species or species habitat known to occur within area
Tursiops aduncus (Arafura/Timor Sea populations)	Spotted bottlenose dolphin (Arafura/Timor Sea populations)	Migratory	Species or species habitat likely to occur within area	Species or species habitat likely to occur within area
Dugong dugon	Dugong	Migratory	Not present	Breeding known to occur within area
Marine reptiles				
Aipysurus apraefrontalis	Short nosed sea snake	Critically endangered	Species or species habitat may occur within area	Species or species habitat likely to occur within area
Caretta caretta	Loggerhead turtle	Endangered and	Congregation or aggregation	Breeding known to occur

Species name	Common name	EPBC Act status	Operational area	Regional area
		migratory	known to occur within area	within area
Chelonia mydas	Green turtle	Vulnerable and migratory	Congregation or aggregation known to occur within area	Breeding known to occur within area
Dermochelys coriacea	Leatherback turtle, leathery turtle	Endangered and migratory	Species or species habitat known to occur within area	Species or species habitat known to occur within area
Eretmochelys imbricata	Hawksbill turtle	Vulnerable and migratory	Congregation or aggregation known to occur within area	Breeding known to occur
Natator depressus	Flatback turtle	Vulnerable and migratory	Congregation or aggregation known to occur within area	Breeding known to occur within area
Sharks & Rays				
Carcharias taurus (west coast population)	Grey nurse shark (west coast population)	Vulnerable	Species or species habitat known to occur within area	Species or species habitat known to occur within area
Carcharodon carcharias	Great white shark	Vulnerable and migratory	Species or species habitat known to occur within area	Species or species habitat known to occur within area
Pristis clavata	Dwarf sawfish, Queensland sawfish	Vulnerable	Species or species habitat known to occur within area	Species or species habitat known to occur within area
Pristis zijsron	Green sawfish, dindagubba, narrow snout sawfish	Vulnerable	Species or species habitat known to occur within area	Species or species habitat known to occur within area
Rhincodon typus	Whale shark	Vulnerable and migratory	Foraging, feeding or related behaviour known to occur within area	Foraging, feeding or related behaviour known to occur within area
Isurus oxyrinchus	Shortfin mako, mako shark	Migratory	Species or species habitat likely to occur within area	Species or species habitat likely to occur within area
Isurus paucus	Longfin mako	Migratory	Species or species habitat likely to occur within area	Species or species habitat likely to occur within area
Manta birostris	Giant manta ray, Chevron manta ray, Pacific manta ray, Pelagic manta ray, oceanic manta ray	Migratory	Species or species habitat known to occur within area	Species or species habitat known to occur within area
Seabirds/shorebirds				
Macronectes giganteus	Southern giant-petrel	Endangered and	Species or species habitat	Species or species habitat

Species name	Common name	EPBC Act status	Operational area	Regional area
		migratory	may occur within area	may occur within area
Pterodroma mollis	Soft-plumaged petrel	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	Foraging, feeding or related behaviour likely to occur within area
Sternula nereis nereis	Australian fairy tern	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	Breeding known to occur within area
Puffinus carneipes	Flesh-footed shearwater, fleshy-footed shearwater	Migratory	Species or species habitat likely to occur within area	Species or species habitat likely to occur within area
Pandion cristatus	Eastern osprey	Migratory	Species or species habitat likely to occur within area	Breeding known to occur within area
Sterna bengalensis	Lesser crested tern	Migratory	Breeding known to occur within area	Breeding known to occur within area
Sterna caspia	Caspian tern	Migratory	Not present	Breeding known to occur within area
Thalassarche melanophris impavida	Campbell albatross	Vulnerable* and migratory	Not present	Species or species habitat may occur within area
Apus pacificus	Fork-tailed swift	Migratory	Not present	Species or species habitat likely to occur within area
Sterna anaethetus	Bridled tern	Migratory	Not present	Breeding known to occur within area
Puffinus pacificus	Wedge-tailed shearwater	Migratory	Not present	Breeding known to occur within area
Sterna dougallii	Roseate tern	Migratory	Not present	Foraging, feeding or related behaviour likely to occur within area
Merops ornatus	Rainbow bee-eater	Migratory	Not present	Species or species habitat may occur within area
Ardea alba	Great egret, white egret	Migratory	Not present	Species or species habitat likely to occur within area
Charadrius veredus	Oriental plover, oriental dotterel	Migratory	Not present	Species or species habitat may occur within area

Species name	Common name	EPBC Act status	Operational area	Regional area
Glareola maldivarum	Oriental pratincole	Migratory	Not present	Species or species habitat may occur within area

2.4 Marine Mammals

Key details of the threatened and migratory marine mammals described in Table 5 are provided Table 6. Based on current knowledge of functional hearing in marine mammals, Southall et al. (2007) defined three distinct, functional groups of cetaceans, based on the frequency range at which their hearing is most sensitive: a) low frequency (LF) cetaceans (7 hertz – 22 kilohertz); b) mid-frequency (MF) cetaceans (150 hertz – 160 kilohertz); c) high frequency (HF) cetaceans (200 hertz to 180 kilohertz). The Pygmy Sperm Whale and Dwarf Sperm Whale are classified as high-frequency hearing cetaceans, both are widely distributed around Australia although there have only been a few sightings of live animals (SPRAT database 21.7.2016). The DoE has not identified any biologically important areas for either of the Pygmy Sperm Whale and Dwarf Sperm Whale in north-west Australian waters. The EPBC listed whales which may occur in the operational area are predominantly low- and mid-frequency cetaceans.

Table 6: Threatened and migratory marine mammals

Common Name: Blue Whale, pygmy blue whale	Scientific Name: *Balaenoptera musculus brevicauda*	
EPBC Act Status: Endangered and migratory	Within Op Area ☒	Within Regional area ☒
Distribution & abundance: There are two subspecies of blue whales that use Australian waters, the pygmy blue whale (*B. m. brevicauda*) and the Antarctic blue whale (*B. m. intermedia*) (Commonwealth of Australia 2015). The Antarctic blue whale is found off the southern coast of WA and Australia and not described herein. Blue whales are considered among the most endangered of all baleen whale populations (Clapham *et al*. 1999). Abundance estimates based on photo-identification mark-recapture from 1999/2000 to 2004/2005 season for blue whales in the Perth Canyon are between 532 and 1,754 individuals, which generally agree with acoustic abundance estimates of 662 to 1,559 calling blue whales migrating south in 2004 past Exmouth in WA (Commonwealth of Australia 2015). In the Perth Canyon (a known aggregation area), up to 40 blue whales have been sighted in a single aerial survey. Preliminary estimates from aerial survey of numbers in the peak period (January–March in 2000–04) have given a maximum of 43; however, numbers are variable from year to year. Known feeding areas include the Perth Basin and the Bonney Upwelling near the Bass Strait. Outside of the recognised feeding areas, possible foraging areas for pygmy blue whales include the greater region around the Perth Canyon, off Exmouth (adjacent to Ningaloo MP) and Scott Reef in WA (Commonwealth of Australia 2015).		
Common Name: Southern Right Whale	Scientific Name: *Eubalaena australis*	
EPBC Act Status: Endangered and migratory	Within Op Area ☒	Within Regional area ☒
Distribution & abundance: The species is generally distributed in the southern hemisphere between 20°S and 60°S (DotE 2015d). They are principally found around the southern coastline off southern WA and far west SA. The global population is expected to be around 12,000 (in 2005) and the Australian population around 2,100. Closest known coastal aggregation area is Flinders Bay on the south-west coast of WA. They are generally thought to be solitary during migration, or accompanied by a dependent calf (DotE 2015d).		
Common Name: Humpback Whale	Scientific Name: *Megaptera novaeangliae*	
EPBC Act status: Vulnerable and migratory	Within Op Area ☒	Within Regional area ☒
Distribution & abundance: This is the most commonly sighted whale in the North-west Marine Region. They migrate annually from their warm water winter breeding areas around the Kimberley coast of WA (between 15-20˚ latitude) to their summer colder feeding waters (Antarctic), south of 56˚S latitude (DotE 2015d). South migration is generally closer to shore, mostly within 200m isobaths. North migration further offshore generally lies within 400 m isobaths (DotE 2015d). A known resting area with calves is located in the Exmouth Gulf (DoIR 2003). Humpbacks are not known to feed while in the region (DotE 2015d). The population that breeds in the Kimberley region is known as the Group IV population and is genetically distinct from the Australian east coast population. The absolute abundance of the Australian west coast population of humpback whale was estimated in 2008 at 28,830 individuals and is predicted to be increasing since the abolition of whaling (DEHWA 2008b).		
Common Name: Antarctic Minke Whale	Scientific Name: *Balaenoptera bonaerensis*	

EPBC Act Status: Migratory	Within Op Area ☒	Within Regional area ☒
Distribution & abundance: Antarctic Minke Whales are not gregarious and tend to swim alone or in pairs (DotE 2015d).These whales are mainly an oceanic species, occurring beyond the continental shelf break (water depths greater than 200 m) (DotE 2015d). Distribution up the west coast of Australia is unknown. In 1990 the International Whaling Commission adopted a population estimate of 760,000, based on results of the IDCR surveys conducted in the seasons 1982/83 through 1988/89 (IWC 1991). Results of subsequent surveys indicated lower abundances due mostly to whaling (DotE 2015d).		
Common Name: Bryde's Whale	Scientific Name: *Balaenoptera edeni*	
EPBC Act Status: Migratory	Within Op Area ☒	Within Regional area ☒
Distribution & abundance: They occur in temperate to tropical waters, oceanic and inshore, bounded by latitudes 40° N and 40° S (DotE 2015d). There appears to be two forms, the coastal form appears to be limited to the 200 m depth isobar, moving along the coast in response to availability of suitable prey (Best *et al*. 1984). The offshore form is found in deeper water (500 m to 1000 m). Estimated numbers off Australia are thought to be similar to that off South Africa (582 ±184 animals) (DotE 2015d). They are opportunistic feeders, readily consuming whatever shoaling prey is available (DotE 2015d). No specific feeding grounds are known.		
Common Name: Killer Whale, Orca	Scientific Name: *Orcinus orca*	
EPBC Act Status: Migratory	Within Op Area ☒	Within Regional area ☒
There are three forms of Orca's; Type A, Type B and Type C. Only Type A are likely to be encountered off the NWS.		
Distribution & abundance: Orca's prefer deep, cold waters and have been recorded along continental slopes (DotE 2015d). The total number in Australian waters is unknown, however, it may be that the total number of mature animals within Australian waters is less than 10 000 (DotE 2015d). No important breeding or resting grounds have been identified in Australia (DotE 2015d). The specific diet of Australian Killer Whales is not known, but there are reports of attacks on dolphins, young humpback whales, blue whales, sperm whales, dugongs and Australian sea lions (Bannister *et al*. 1996). This suggests that they will come inshore to feed, following the migration of these species.		
Common Name: Sperm Whale	Scientific Name: *Physeter macrocephalus*	
EPBC Act Status: Migratory	Within Op Area ☒	Within Regional area ☒
Distribution & abundance: Wide distribution throughout Australia (DotE 2015d). Sperm whales tend to inhabit offshore areas more than 600m deep and are uncommon in waters less than 300 m deep (DotE 2015d) and are deep divers. They are gregarious and can live in groups of up to 50 individuals. No population estimates are available for Australian waters, though it is likely that the total number of mature animals within Australian waters is less than 10,000 (DotE 2015d). They feed on oceanic cephalopods (frequently taken at depth) (Clarke 1980), medium and large demersal fish including rays, sharks and teleosts (DotE 2015d).		
Common Name: Indo-Pacific Humpback Dolphin	Scientific Name: *Sousa chinensis*	
EPBC Act Status: Migratory	Within Op Area ☒	Within Regional area ☒
Distribution & abundance: They are known to occur along the northern coastline of Australia, extending to Exmouth Gulf on the west coast (25° S) (DotE 2015d). They inhabit shallow coastal, estuarine, and occasionally riverine habitats, in tropical and subtropical regions. The species usually occurs close to the coast, generally in depths of less than 20 m, but have been seen 55 km offshore in shallow water. Little is known of the WA population numbers (DotE 2015d). A survey in April 2010 recorded a total of 42 groups off the North West Cape. Group size ranged from 1 to 15, with a mean (± SE) of 5.3 (± 0.48) individuals. A total of 54 were identified (Brown *et al* 2012).		
Common Name: Spotted Bottlenose Dolphin (Arafura/Timor Sea populations)		Scientific Name: *Tursiops aduncus*
EPBC Act Status: Migratory	Within Op Area ☒	Within Regional area ☒
Distribution & abundance: Tend to move individually or in small pods generally distributed in the tropical waters of the North-west Marine Region, along the Pilbara and Kimberley coasts and inhabiting shallow coastal waters along the continental shelf (DotE 2015d).		
Common Name: Dugong	Scientific Name: *Dugong dugon*	
EPBC Act Status: Migratory	Within Op Area ☐	Within Regional area ☒
Distribution & abundance: The waters of Exmouth Gulf and the Ningaloo coast are considered a BIA for dugongs and dugongs calve and nurse their young in the gulf and along the Pilbara coast between September and February. Found in shallow (less than 5 m deep) sheltered areas, often near island or large bays. Dugong numbers in Ningaloo MP are estimated at 1,000 individuals (DotE 2015d). Large concentrations seen further south in the Exmouth Gulf or Shark Bay (Prince 1986). Distribution around Barrow Island, Airlie Island, Lowendal Islands and the Montebello Islands further offshore, with the Pilbara population estimated to be around 2,046 individuals (Prince *et al* 2001). Calving sites are usually in shallow waters like tidal banks, and the species feeds on a highly specialised diet of selected species of seagrass (especially species of the genera *Halophila* and *Halodule*), in wide shallow protected areas (DotE 2015d). Marine algae is also eaten, but is believed to be eaten only when seagrass is scarce (DotE 2015d). Specific areas supporting dugongs include Ningaloo and Exmouth Gulf.		

2.5 Marine Reptiles

Key details of the threatened and migratory marine reptiles described in Table 5 are provided in Table 7 below.

Table 7: Threatened and migratory marine reptiles

Common Name: Short-nosed Seasnake	Scientific Name: *Aipysurus apraefrontalis*	
EPBC Act Status: Critically Endangered	Within Op Area ☐	Within Regional area ☒
Distribution & abundance: Short nosed seasnake inhabits shallow waters along the outer edge of reefs in depths up to 10 m, or on reef flats, but have been observed to move up to 50 km away from their habitat. Recorded from Exmouth Gulf in the south to the Sahul Shelf to the north of the NWS (DotE 2015d).		
Common Name: Loggerhead Turtle	Scientific Name: *Caretta caretta*	
EPBC Act Status: Endangered, Migratory	Within Op Area ☒	Within Regional area ☒
Distribution & abundance: WA supports one genetic stock of loggerhead turtle with important nesting sites on South Muiron Island, the NWC and Dirk Hartog Island off Shark Bay (Limpus 2008a). Occasional nesting has also been recorded on Barrow Island, Lowendal Islands and as far north as the Dampier Archipelago (DotE 2015d). Estimated annual population of nesting females in WA: 1,000s (DotE 2015d). Hatchlings to sub-adult loggerheads occur in the open ocean foraging on planktonic organisms, algae and pelagic crustaceans (~15 years) before moving to their chosen inshore feeding areas as adults. Adult inshore feeding areas include a wide variety of tidal and sub-tidal feeding habitat areas including rocky and coral reefs, muddy bays, sand flats, estuaries and seagrass meadows up to 50 m water depth where they feed on benthic invertebrates such as molluscs and bivalves (Limpus 2008a).		
Common Name: Leatherback Turtle	Scientific Name: *Dermochelys coriacea*	
EPBC Act Status: Endangered, Migratory	Within Op Area ☒	Within Regional area ☒
Distribution & abundance: Widespread foraging off WA coast; though there are not known to nest in WA.		
Common Name: Green Turtle	Scientific Name: *Chelonia mydas*	
EPBC Act Status: Vulnerable, Migratory	Within Op Area ☒	Within Regional area ☒
Distribution & abundance: Estimated annual population of nesting females in WA: 10,000 to 30,000. In WA, one genetic stock of green turtles is found from Ningaloo Coast to the Lacepede Islands, comprising one of the largest green turtle populations in the Indian Ocean and the world (Limpus 2008b). Known nesting locations Ningaloo Coast, Barrow Island, Montebello Islands, Lacepede Islands, Kimberley region. They have also been reported to nest on the Muiron, Thevenard, Airlie, Varanus, Serrurier and Locker Islands in the Pilbara region (RPS 2010). Green turtles forage on seagrass and algae and travel in relatively shallow waters, less than 25 m deep (Chevron Australia 2012).		
Common Name: Hawksbill Turtle	Scientific Name: *Eretmochelys imbricata*	
EPBC Act Status: Vulnerable, Migratory	Within Op Area ☒	Within Regional area ☒
Distribution & abundance: Estimated annual population of nesting females in WA: 1,000s. Hawksbill turtles generally forage and travel in shallow waters less than 10 m deep in the Pilbara region, based on tracking data (Chevron Australia 2012). Known nesting locations are Ningaloo Coast, Lowendal Islands, Varanus Island, Rosemary Island, Dampier, Archipelago to Montebello Islands, Thevenard Island, Barrow Island, and possibly in the Kimberley. In addition the Muiron Island has also been reported as a nesting site (DoE, 2015b, Mortimer, J.A & Donnelly, M. (IUCN SSC Marine Turtle Specialist Group). 2008).The species feed mainly on benthic habitats which include coral, rocky reefs, sponges and algae. Chevron identified that hawksbill turtles generally forage and travel in shallow waters less than 10 m deep in the Pilbara region, based on tracking data (Chevron Australia 2012).		
Common Name: Flatback Turtle	Scientific Name: *Natator depressus*	
EPBC Act Status: Vulnerable, Migratory	Within Op Area ☐☒	Within Regional area ☒
Distribution & abundance: Flatbacks are found only in the tropical waters of northern Australia, Papua New Guinea and Irian Jaya. The species is the second most abundant sea turtle in northern WA waters, but is still vulnerable. Flatback turtles forage near shore on soft bottomed habitats. The species targets soft bodied invertebrates and tend travel in water depths less than 70 m deep (Chevron Australia 2012). Nesting areas of flatback turtles within WA range from Exmouth to the Lacepede Islands, with significant rookeries located around the Dampier Archipelago, Barrow, Thevenard and Varanus Islands, the Montebello Group, the Kimberley region, and on some mainland beaches including Mundabullangana near Port Hedland (Limpus 2007). All recorded nesting beaches are in Australia. Estimated annual population of nesting females in WA: 1,000s to 10,000.		

2.6 Sharks and Rays

A summary of key details of the threatened and migratory sharks and rays described in Table 5 is provided in Table 8 below.

Table 8: Threatened and migratory sharks and rays

Common Name: Grey Nurse Shark	Scientific Name: *Carcharias taurus (west coast population)*	
EPBC Act Status: Vulnerable	Within Op Area ☒	Within Regional area ☒
Distribution & abundance: Widely distributed along the WA coast and are still regularly encountered, albeit with low and irregular frequency (DotE 2015d). The species has been recorded at varying depths, but is generally found between 15–40 m (DotE 2015d); and are often observed hovering motionless just above the seabed, in or near deep sandy-bottomed gutters or rocky caves, and in the vicinity of inshore rocky reefs and islands (DotE 2015d). Grey nurse sharks have also been recorded in the surf zone, around coral reefs, and to depths of around 200 m on the continental shelf (DotE 2015d).		
Common Name: Great White Shark	Scientific Name: *Carcharodon carcharias*	
EPBC Act Status: Vulnerable, Migratory	Within Op Area ☒	Within Regional area ☒
Distribution & abundance: Great white sharks can be found from close inshore around rocky reefs, surf beaches and shallow coastal bays to outer continental shelf and slope areas (DotE 2015d). They also make open ocean excursions and can cross ocean basins. They are transient within the north-west marine region as they are known to prey on humpback whales and have been recorded in NWC waters during migration season		
Common Name: Dwarf Sawfish, Queensland Sawfish		Scientific Name: *Pristis clavata*
EPBC Act Status: Vulnerable	Within Op Area ☒	Within Regional area ☒
Distribution & abundance: Sawfish are generally found along the north-west coast of WA down to the Pilbara region (DotE 2015d). Dwarf sawfish regularly use the tidal creeks and mangrove areas of Roebuck Bay, within the north-west marine region, for breeding and refuge (Bennelongia 2009).		
Common Name: Green Sawfish	Scientific Name: *Pristis zijsron*	
EPBC Act Status: Vulnerable	Within Op Area ☒	Within Regional area ☒
Distribution & abundance: Green sawfish have historically been recorded in the coastal waters off Broome, WA, around northern Australia and down the east coast as far as Jervis Bay, New South Wales (DotE 2015d). Green sawfish been recorded in inshore marine waters, estuaries, river mouths, embankments and along sandy and muddy beaches (DotE 2015d). Green sawfish have been recorded in very shallow water (<1 m) to offshore trawl grounds in over 70 m of water (DotE 2015d).		
Common Name: Whale Shark	Scientific Name: *Rhincodon typus*	
EPBC Act Status: Vulnerable	Within Op Area ☒	Within Regional area ☒
Distribution & abundance: Whale Sharks are found in all tropical seas (DoF 2015a) and are most commonly seen in waters off northern Western Australia, Northern Territory and Queensland (DotE 2015d). Ningaloo Reef is the main known aggregation point in Australian waters. Annual numbers at the Reef is estimated to vary between 300-500 individuals (DotE 2015d). Whale shark presence coincides with the coral mass spawning period (March/April), when there is an abundance of food (krill, planktonic larvae and schools of small fish) in the waters adjacent to the reef.		
Common Name: Giant Manta Ray	Scientific Name: *Manta birostris*	
EPBC Act Status: Migratory	Within Op Area ☒	Within Regional area ☒
Distribution & abundance: Found in tropical marine waters worldwide and only on occasion in temperate regions (DoF 2011). They feed on plankton (DoF 2011)		
Common Name: Longfin Mako	Scientific Name: *Isurus paucus*	
EPBC Act Status: Migratory	Within Op Area ☒	Within Regional area ☒
Distribution & abundance: Worldwide distribution in tropical and warm temperate oceans. A little-known epipelagic shark, the species is apparently deep-dwelling, although both sightings on the ocean surface and the species' diet suggest a much greater depth range (Reardon *et al* 2006). Present records are sporadic and known behaviour remains unclear (Reardon *et al* 2006).		
Seasonality & migration: Unknown		
Common Name: Shortfin Mako, Mako Shark	Scientific Name: *Isurus oxyrinchus*	
EPBC Act Status: Migratory	Within Op Area ☒	Within Regional area ☒
Distribution & abundance: It is a coastal, oceanic species occurring from the surface to at least 500 m depth and is widespread in temperate and tropical waters of all oceans from 50°N to 50°S. It is occasionally found close inshore where the continental shelf is narrow. It is not normally found in waters below 16°C (Cailliet *et al* 2009). Usually spending its time in coastal waters up to 50 m depth and open waters, although studies indicate they occasionally dive to depths over 600 m (DotE 2015d).		

2.7 Birds

A summary of key details of the threatened and migratory birds described in Table 5 is provided in Table 9 below.

Table 9: Threatened and migratory birds

Common Name: Southern Giant-Petrel	Scientific Name: *Macronectes giganteus*	
EPBC Act Status: Endangered, Migratory	Within Op Area ☒	Within Regional area ☒
Distribution & abundance: Occurs in Antarctic to subtropical waters and breeds on six subantarctic and Antarctic islands in the Australian territory. The world population of approximately 62 000 individuals of which approximately 7090 breeding pairs breed in Australian territory of the Antarctic annually (DotE 2015d). The Southern Giant-Petrel is an opportunist scavenger and predator. In Australian waters it feeds on octopus and squids and krill, taken by surface-seizing. It is also recorded consuming other crustaceans, kelp, fish, jellyfish, and rabbits. In the Antarctic it feeds on penguin, seal and whale carrion (DotE 2015d).		
Common Name: Soft-plumaged Petrel	Scientific Name: *Pterodroma mollis*	
EPBC Act Status: Vulnerable	Within Op Area ☒	Within Regional area ☒
Distribution & abundance: Species is a marine, oceanic species. They feed mostly on cephalopods, some fish and crustaceans. The birds burrow among tussock grass and ferns on slopes and valleys to nest (DotE 2015d).Most numerous between 30° and 50°S and is a regular visitor to west Australian coasts (DotE 2015d). The population in Australia is unknown. The only known Australian breeding population occurs on Maatsuyker Island, and consists of less than 10 pairs.		
Common Name: Australian Fairy Tern	Scientific Name: *Sternula nereis nereis*	
EPBC Act Status: Vulnerable	Within Op Area ☒	Within Regional area ☒
Distribution & abundance: Found along the coasts of WA as far north as the Dampier Archipelago near Karratha (DotE 2015d). They nest on sheltered sandy beaches spits and banks above high tide line and below vegetation. They predates on small bait-sized fish (DotE 2015d).The total number of mature Fairy Terns (Australian) has been estimated at 3000–9000 individuals (DotE 2015d). More specific estimates, from 2007, indicate numbers of approximately 4300 (DotE 2015d). In WA there are less than 1600 pairs, but the population appears to be relatively stable (DotE 2015d).		
Common Name: Flesh-footed shearwater, fleshy-footed shearwater	Scientific Name: *Puffinus carneipes*	
EPBC Act Status: Migratory	Within Op Area ☒	Within Regional area ☒
Distribution & abundance: Pairs nest in an enlarged chamber at the end of a nesting burrow on islands off the coast. The birds forage almost entirely at sea and very rarely on land (DotE 2015).They are common visitors to waters of the continental shelf and continental slope off south-western WA (DotE 2015d). Most breeding populations within Australian jurisdiction are poorly known (DotE 2015d).		
Common Name: Eastern Osprey	Scientific Name: *Pandion cristatus*	
EPBC Act Status: Migratory	Within Op Area ☒	Within Regional area ☒
Distribution & abundance: The distribution of the species is around the northern coast of Australia (south-western WA to south-eastern NSW) and appears continuous except for a possible gap at Eighty Mile Beach (DotE 2015d). The Eastern Osprey is considered to be moderately common in Australia (DotE 2015d) and mainly feed on fish. They construct nests in a variety of natural and artificial sites including in dead or partly dead trees or bushes; on cliffs, rocks, rock stacks or islets; on the ground on rocky headlands, coral cays, deserted beaches, sand hills or saltmarshes; and on artificial nest platforms, pylons, jetties, lighthouses, navigation towers, cranes, exposed shipwrecks and offshore drilling rigs (DotE 2015d).		
Common Name: Lesser crested tern	Scientific Name: *Sterna bengalensis*	
EPBC Act Status: Migratory	Within Op Area ☒	Within Regional area ☒
Distribution & abundance: This species breeds in subtropical coastal parts of the world mainly from the Red Sea across the Indian Ocean to the western Pacific, and Australia. Records of breeding locations include islands off Queensland (Birdlife International 2015). It is known to breed on Adele Island, Ashmore Reef, Lacepede, Bedout and Y Islands and Beacon Island within the Lowendal Group. Beacon Island recorded up to 5000 nests (Nicholson 1998).		
Common Name: Caspian tern	Scientific Name: *Sterna caspia*	
EPBC Act Status: Migratory	Within Op Area ☐	Within Regional area ☒
Distribution & abundance: Widespread in coastal regions of WA, from the Great Australian Bight to the Dampier Peninsula (DotE 2015d). Breeding occurs in the Pilbara region from around Point Cloates to North Turtle Island (DotE 2015d). The nest is a deep scrape on the ground. The diet consists predominantly of fish as well as the eggs and young of other birds, carrion, aquatic invertebrates (e.g. crayfish), flying insects and earthworms (DotE 2015d).		
Seasonality & migration: In Australia, the Caspian Tern is a resident and present throughout the year at sites where breeding occurs year round and also at some sites where breeding is protracted (e.g. Darwin and WA). On Montebello Island, in the Pilbara region of WA, breeding is protracted		

with eggs recorded between late April and August (DotE 2015d).		
Common Name: Campbell albatross	Scientific Name: *Thalassarche melanophris impavida*	
EPBC Act Status: Vulnerable* and migratory	Within Op Area ☐	Within Regional area ☒
Distribution & abundance: A non-breeding visitor to Australian waters. They are most commonly seen foraging over the oceanic continental slopes off Tasmania, Victoria and New South Wales. After breeding, birds move north and may enter Australia's temperate shelf waters (DotE 2015d). The Campbell Albatross is a marine sea bird inhabiting sub-Antarctic and subtropical waters from pelagic to shelf-break water habitats. It feeds on krill and fish, with some cephalopods, salps and jellyfish.		
Common Name: Fork-tailed swift	Scientific Name: Apus pacificus	
EPBC Act Status: Migratory	Within Op Area ☐	Within Regional area ☒
Distribution & abundance: A non-breeding visitor to all states and territories of Australia (DotE 2015d). They are scattered along the coast from south-west Pilbara to the north and east Kimberley region. In Australia, they mostly occur over inland plains but sometimes above foothills or in coastal areas. They often occur over cliffs and beaches and also over islands and sometimes well out to sea (DotE 2015d). The species food items within Australia are not well known, however, it is known to be insectivorous (DotE 2015d).		
Common Name: Bridled tern	Scientific Name: *Sterna anaethetus*	
EPBC Act Status: Migratory	Within Op Area ☐	Within Regional area ☒
Distribution & abundance: In Australia, distribution is widespread, breeding on offshore islands in western, northern and north-eastern Australia. The species forages in offshore, continental shelf waters and is only rarely recorded along mainland coasts. Lowendal Islands, >10 000 breeding pairs, with 3000–4000 pairs on Bridled Island (DotE 2015d). They nest on the ground, usually under vegetation or in rocky areas that provide shelter. They feed on a range of species of fish, crustaceans, cephalopods and insects.		
Common Name: Wedge-tailed shearwater	Scientific Name: *Puffinus pacificus*	
EPBC Act Status: Migratory	Within Op Area ☐	Within Regional area ☒
Distribution & abundance: Breed on islands off the west coast of WA. At WA breeding sites there are at least one million breeding pairs (DotE 2015d). The species usually excavates burrows on flat or flattish areas with dense grassy and tussocky vegetation. It is a pelagic, marine bird known from tropical and subtropical waters. They mostly consume fish, some cephalopods, insects, jellyfish and prawns (DotE 2015d).		
Common Name: Roseate tern	Scientific Name: *Sterna dougallii*	
EPBC Act Status: Migratory	Within Op Area ☐	Within Regional area ☒
Distribution & abundance: In WA, the subspecies is regularly recorded north from Mandurah to around Eighty Mile Beach, in the Pilbara region. The Australian population was estimated to be at least 15 000 pairs. It occurs in coastal and marine areas in subtropical and tropical seas. The species inhabits rocky and sandy beaches, coral reefs, sand cays and offshore islands. They usually roost or loaf in the intertidal zone on islands, including on the upper sections of beaches, above the high-water mark (DotE 2015d). They feed mostly on fish.		
Common Name: Rainbow bee-eater	Scientific Name: *Merops ornatus*	
EPBC Act Status: Migratory	Within Op Area ☐	Within Regional area ☒
Distribution & abundance: It is distributed across much of mainland Australia, and occurs on several near-shore islands. The Rainbow Bee-eater occurs mainly in open forests and woodlands and shrublands, but occurs in inland and coastal sand dune systems, and in mangroves in northern Australia (DotE 2015d). It mainly feeds on insects.		
Common Name: Great egret, white egret	Scientific Name: *Ardea alba*	
EPBC Act Status: Migratory	Within Op Area ☐	Within Regional area ☒
Distribution & abundance: They are widespread in Australia. They occur in all states/territories of mainland Australia and have also been recorded as vagrants on offshore islands. They inhabit a wide range of wetland habitats e.g. inland and coastal including estuarine mudflats, tidal streams; mangrove swamps; coastal lagoons; and offshore reefs (DotE 2015d). They have a diverse diet that includes fish, insects, crustaceans, molluscs, frogs, lizards, snakes and small birds and mammals. Breeding sites are located in wooded and shrubby swamps including mangrove forests (DotE 2015d).		
Common Name: Oriental plover, oriental dotterel		Scientific Name: *Charadrius veredus*
EPBC Act Status: Migratory	Within Op Area ☐	Within Regional area ☒
Distribution & abundance: Non-breeding visitor to Australia, where the species occurs in both coastal and inland areas, mostly in northern Australia. Most records are along the north-western coast, between Exmouth Gulf and Derby in WA (DotE 2015d). Internationally important sites in WA and maximum counts include Eighty Mile Beach (57,619), Port Hedland Saltworks (29,900), Roebuck Bay (8,750), and Dampier Saltworks (1,830). They sometimes roost on soft wet mud or in shallow water of beaches and tidal mudflats (DotE 2015d). They usually forage among short grass or on hard stony bare ground, but also on mudflats or among beachcast seaweed on beaches (DotE 2015d).		
Common Name: Oriental pratincole	Scientific Name: *Glareola maldivarum*	
EPBC Act Status: Migratory	Within Op Area ☐	Within Regional area ☒

Distribution & abundance: Within Australia it is widespread in northern areas in summer, especially along the coasts of the Pilbara region and the Kimberley Division in WA. Internationally (in bold) and nationally important sites in WA and maximum counts (in brackets) include: Eighty Mile Beach (2.88 million), Roebuck Plains (50,000), and Port Hedland Saltworks (10,000). Most of the migratory population of the species is thought to spend the non-breeding season in Australia (DotE 2015d). The species does not breed in Australia (DotE 2015d).

2.8 Protected and Significant Areas

As per Regulation 10A of the OPGGS(E)R 2009, no activity or part of the activity, other than arrangements for environmental monitoring or for responding to an emergency, will be undertaken in any part of a declared World Heritage property.

A summary of key protected and significant areas within the operational area (OA) and regional area (RA) is provided in Table 10.

Table 10: Summary of the Values and Management Principles / Actions / Objectives for Protected Areas Relevant to the Activity

Protected Area	Summary of Values and Sensitivities	OA	RA
Commonwealth Marine Reserves (CMR)			
Gascoyne CMR	Gascoyne CMR is listed as a Type B Reserve – New CMR boundaries and zoning re-proclaimed. Category ii: National Park: Protected Area managed mainly for ecosystem conservation and recreation. There are no specific buffer requirements for petroleum activities. Values of this CMR include: ▪ Important foraging areas for (DotE 2015b): – migratory seabirds; – threatened and migratory hawksbills and flatback turtles; and – vulnerable and migratory whale sharks. ▪ Provides a continuous connectivity corridor from shallow depths (~15 m) out to deep offshore waters on the abyssal plain (>5000 m). ▪ Provides protection to many seafloor features including canyon, terrace, ridge, knolls, deep hole/valley and continental rise. It also provides protection for sponge gardens in the south of the reserve adjacent to WA coastal waters. ▪ Examples of the ecosystems of the Central Western Shelf Transition, the Central Western Transition and the Northwest province provincial bioregions as well as the Ningaloo meso-scale bioregion. ▪ The canyons are believed to be associated with the movement of nutrients from deep water over the Cuvier Abyssal Plain onto the slope where mixing with overlying water layers occurs at the canyon heads. These canyon heads, including that of Cloates Canyon, are sites of species aggregation and are thought to play a significant role in maintaining the ecosystems and biodiversity associated with the adjacent Ningaloo Reef. ▪ The reserve therefore provides connectivity between the inshore waters of the existing Ningaloo Commonwealth marine park and the deeper waters of the area.	✓	✓
Ningaloo CMR	Major conservation values include (DotE 2015c): ▪ Foraging areas for vulnerable and migratory whale sharks; ▪ Foraging areas and adjacent to important nesting sites for marine turtles; ▪ Includes part of the migratory pathway of the protected humpback whale;	×	✓

Protected Area	Summary of Values and Sensitivities	OA	RA
	▪ Includes shallow shelf environments and provides protection for shelf and slope habitats, as well as pinnacle and terrace seafloor features; and ▪ Examples of the seafloor habitats and communities of the Central Western Shelf Transition.		
State Marine Parks (MP) and Marine Management Areas (MMA)			
Ningaloo MP	Major conservation values include (CALM & MPRA 2005): ▪ Largest fringing reef in Australia and provides unique geomorphology with a variety of marine habitat types and high species diversity; ▪ Key ecosystems include coral reef communities, filter feeding communities (sponges, tunicates and cnidarians), shoreline intertidal reef communities, soft sediment communities, macroalgal meadows and seagrass communities, mangrove communities and rocky coastlines; ▪ Important breeding and feeding habitats for threatened and migratory seabirds, shorebirds, fish, sharks, rays, dugongs and turtles; ▪ Whale sharks aggregate annually from March to June, and twenty species of whales and dolphins have been recorded in the area; ▪ Provides significant nature-based tourism industry in the Exmouth region and has major cultural aesthetic, recreational and economic attributes of the area.	×	✓
Muiron Islands MMA	The Muiron Islands are located off the north of the NWC, and are managed in conjunction of the Ningaloo MP, as they share many of the same features listed above (CALM & MPRA 2005).	×	✓
Barrow Island MP	Barrow Island, the Lowendal Islands and the Montebello Islands are part of a shallow submarine ridge. These islands are protected within the Montebello and Barrow Islands MCR within WA State waters, which consists of two marine parks and one management area (DEC 2007). Ecological and conservation values include: ▪ Subtidal and intertidal reefs, sheltered lagoons, channels, beaches and cliffs; ▪ Pristine sediment and water quality; ▪ Key ecosystems ▪ The waters provide an offshore resting area for migrating humpback whales and calves, and many other cetaceans visit the waters; ▪ Important reserve for feeding and resting migratory birds, as well as providing important nesting areas and rookeries; ▪ Supports richness of finfishes and diverse marine invertebrate fauna, some of which are endemic and rare; and ▪ Social values	×	✓
Barrow Island MMA		×	✓
Montebello Islands MP (outside of regional area)		×	×
World Heritage Area (WHA)			
The Ningaloo Coast WHA	The outstanding values of marine protected areas including Ningaloo MP, Ningaloo CMR and the Muiron Islands MMA have been recognised at an international level with their inclusion within the Ningaloo Coast WHA. Ningaloo is also listed as National Heritage Place and Commonwealth Heritage Place. Also see CMR and State MPs and MMAs.	×	✓

Protected Area	Summary of Values and Sensitivities	OA	RA
Key ecological feature (KEF)			
Ancient coastline at 125 m depth contour	A terrace step at a depth of approximately 125 m has been suggested that humpback whales, whale sharks and other migratory pelagic species may use this escarpment as a guide as they move through the region (Falkner *et al*. 2009).	✓	✓
Canyons linking the Cuvier Abyssal Plain with the Cape Range Peninsula	Deep water upwelling is channelled through the narrow canyons bringing nutrient rich waters from the Antarctic Intermediate water mass (Brewer *et al.,* 2007) to the surface and the narrow shelf adjacent to the Ningaloo Reef, meaning that the nutrients are immediately available to reef consumers (Brewer *et al.,* 2007). The sites see localised seasonal biological productivity associated with bursts of phytoplankton, zooplankton and tropical krill production that have a significant influence on the adjacent Ningaloo Reef, and are a major source of nutrients to the reef.	✓	✓
Commonwealth waters adjacent to Ningaloo Reef	(See CMRs).	×	✓
Continental slope demersal fish communities	High species diversity and endemism, including the most diverse slope bioregion in Australia with over 500 species found with over 64 of those species occurring nowhere else (DotE 2015b).	✓	✓
Exmouth Plateau	Largest topographical feature of the North-west marine bioregion. The surface of the plateau is generally rough and undulating and is thought to be dotted with pinnacles. It is an important geomorphic feature that modifies the flow of deep waters and contributes to the generation of internal waves and the potential of uplifting deeper, more nutrient-rich waters, closer to the surface (Brewer *et al*. 2007).	✓	✓
Biologically Important Areas (BIAs)			
Pygmy blue whale migration route (north and south)	The northern and southern migration corridor for pygmy blue whales migrating along the coast off WA between the Bonney Upwelling system in the Great Australian Bight and Indonesia, and passing Exmouth in the period April to August (Double et al. 2012).	✓	✓
Humpback whale migration route (north and south)	The northward migration past the Montebello and Barrow Islands generally occurs from mid-July with the peak in late July, varying by up to 3 weeks. The southern migration commences as early as August/early September in this region, with peak of cow/calf pairs occurring in late September to early October (DotE 2015).	✓	✓
Humpback whale resting area (Exmouth Gulf)	October and early November have been recorded by Jenner and Jenner (2004) as high density periods for cow/calves pairs within the Exmouth Gulf resting area.	×	✓
Dugong foraging area (Ningaloo Coast)	The waters of Exmouth Gulf and the Ningaloo coast are considered a BIA for dugongs and dugongs calve and nurse their young in the gulf and along the Pilbara coast between September and February.	×	✓
Dugong breeding, calving, foraging and nursing area (Exmouth Gulf)		×	✓
Loggerhead turtle nesting	Breeding and nesting occurs November-March, peak in December-February.	×	✓

Protected Area	Summary of Values and Sensitivities	OA	RA
Loggerhead turtle inter-nesting buffer	Inter-nesting range varies between marine turtle species, and is not known for Loggerheads in the Pilbara. However, based on a study in Dry Tortugas National Park in the USA, it is likely that Loggerhead females will inter-nest in close proximity (within 5 km) of the nesting beach and within shallow water (<15 m) (Hart et al. 2010), which consistent with the behaviour other marine turtle species in the Pilbara (Pendoley 2005).	✓	✓
Green turtle nesting, foraging, mating, aggregation, basking and inter-nesting	Off WA coast and nesting mainly from August to March; December-January peak. Low level year round. On Barrow Island, where there have been extensive nesting surveys, the green turtle nesting season begins in November, peaks in January to February and ends in April (DSEWPaC 2012). Inter-nesting data shows green turtles remain in close proximity (<5 km) to Barrow Island, Rosemary Island and Varanus Island beaches selected for egg laying (Pendoley 2005). Aggregation area is on the outside boundary of the regional area west of the Lowendal Islands.	×	✓
Green turtle inter-nesting buffer		✓	✓
Hawksbill turtle nesting, foraging, mating and inter-nesting	Off WA coast all year round with nesting mainly from August to December; October-November peak (EPA 2010) and potentially through to January (Limpus 2009). Inter-nesting data also shows hawksbill turtles remain in close proximity (<5 km) to nesting beaches (Pendoley 2005).	×	✓
Hawksbill turtle inter-nesting buffer		✓	✓
Flatback turtle nesting, foraging, mating, aggregation and inter-nesting	Off WA coast nesting is November to March; December-January peak (EPA 2010). Inter-nesting data shows flatback turtles travel up to 50 to 62 km from nesting beaches (Woodside 2011; Whittock et al. 2014). Aggregation area is on the outside boundary of the regional area west of the Lowendal Islands.	×	✓
Flatback turtle inter-nesting buffer		✓	✓
Whale shark aggregation/ foraging area (Ningaloo)	Whale Sharks aggregate in the reef front waters adjacent to the Ningaloo Reef between March to June (Wilson et al. 2006) with the highest frequency of sightings occurring in April (DotE 2015); however aggregations have been reported to extend through July (DPaW 2013).	×	✓
Whale shark foraging area north of the North West Cape	Foraging areas as mapped by the National Conservation Atlas for offshore Ningaloo and offshore Muiron Island in the NWS. Wilson et al. (2006) reported that tagged whale sharks departed Ningaloo Reef between May and June, with two endpoints at Ashmore and Scott Reefs by July and August, respectively.	✓	✓
Lesser crested tern breeding area	Known to breed on Adele Island, Ashmore Reef, Lacepede, Bedout Island and Beacon Island within the Lowendal Group (the latter area between March and May; Nicholoson 1988).	✓	✓
Wedge-tailed shearwater breeding area	Breed on islands off the west coast of WA, with egg laying occurring late October to early November and departing nests in early April to early May (DotE 2015).	✓	✓
Roseate tern breeding area	Breeding in WA occurs in two quite distinct periods, with peak months for laying April to November. At some sites, breeding occurs during both late spring-summer and late autumn-winter (e.g. Montebello Islands).	×	✓
Fairy tern breeding area	Found along the coasts of WA as far north as the Dampier Archipelago near Karratha (DotE 2015). Nesting on sheltered sandy beaches spits and banks above high tide line and below vegetation.	×	✓

2.9 Socioeconomic Environment

2.9.1 Commercial Fisheries

A summary of Commonwealth and State managed fisheries within the operational area (OA) and regional area (RA) is provided in Table 11.

Table 11: Summary of commercial fisheries

Aspect/feature	Description of presence/ activity	OA	RA
Commercial fisheries (Commonwealth managed)			
North West Slope Trawl Fishery (NWSTF)	No effort occurred within the operational area in 2012-13, however a small portion of the area fished overlapped with the eastern boundary of the Regional area (ABARES 2014). This is also similar to the area fishing in 2013-2014 as described in ABARES (2015). Effort occurs beyond the 200 m isobaths in the north-west of WA targeting scampi fishery and a small amount of demersal trawl gear. A total of 37.5 tonnes were landed over 103 days from one vessel in 2012-13 (ABARES 2014). A total of 45.7 tonnes were landed over 119 days from one vessel in 2013-14 (ABARES 2014).	✓	✓
Western Deepwater Trawl Fishery (WDTF)	No effort overlapped with the operational or regional area in the 2012-13 fishing season and the 2013-15 (ABARES 2014, 2015). The closest effort occurred approximately 100 km south of the area, off the Ningaloo Coast. Effort is concentrated seaward of the 200 m depth contour using demersal trawl. Two vessels were active in 2012-13, landing a total of 15.2 tonnes over 19 days effort (ABARES 2014). Three vessels were active in 2013-2014, landing a total of 9.8 tonnes over 13 days effort (ABARES 2014).	✓	✓
Western Skipjack Tuna Fishery	No catch or effort has occurred for this fishery since the 2008-09 fishing season due to variability in the availability of skipjack tuna in the Australian Fishing Zone and the prices received for the product (ABARES 2014, 2015).	✓	✓
Western Tuna and Billfish Fishery (WTBF)	352 tonnes of catch were landed in the 2013 season from four vessels using pelagic long lines (ABARES 2014). This reduced to 316 tonne of catch in 2014 from the same vessel effort (ABARES 2015). Catch mainly consisted of striped marlin, swordfish, albacore, bigeye tuna and yellowfin tuna. Some fishing effort overlapped with the operational and regional areas in the 2013 season (ABARES 2014); however in recent years, effort has concentrated off south-west Western Australia (ABARES 2015).	✓	✓
Commercial fisheries (State managed)			
West Coast Rock Lobster Managed Fishery	In the 2013 season 5,641 tonnes of rock lobster were landed commercially from 251 vessels, and 128 tonnes landed through recreational fishing. Fishing can occur all year round (DoF 2014). Rock lobsters are a temperate species, only found on the continental shelf (up to 200m) off the coast with most living between Perth and Geraldton (Bellchambers *et al.* 2012; DoF 2015c). Zone B of the fishery is located in the most southerly extent of the regional area. Based on distribution maps (DoF 2015c), the upper extent of Zone B reflects the upper extent of the northern distribution; Zone B covers an extensive area south as far as Green Head. No commercial fishing is known from the operational area (DoF pers. Comm. 2016).	×	✓

Aspect/feature	Description of presence/ activity	OA	RA
Exmouth Gulf Prawn Managed Fishery	585 tonnes of prawns were landed in the 2013 season from six operating vessels. The area trawled in 2013 overlaps with the southern boundary of the regional area, located within the Exmouth Gulf, south of the Muiron Islands. No effort was recorded in the operational area in 2013 (DoF 2014).	×	✓
Pearl Oyster Managed Fishery	A total of 517,653 shells were collected in the 2013 season. None were collected from Zone 1 (NWC including the Exmouth Gulf), which intersects the regional area. There has been no fishing in Zone 1, which overlaps the operational and regional areas, since 2008 (DoF 2014). Consultation with Pearl Produces Association (PPA) confirmed the main interest is in the vicinity of 80 Mile Beach and there are no active pearling leases in this area.	✓	✓
Onslow Prawn Managed Fishery	Less than one tonne of prawns were collected in the 2013 fishing year (DoF 2014). All fishing effort was concentrated in a small area adjacent to the mainland, south-east of Barrow Island and a 10km long area west of Onslow. The latter area intersects the south-eastern boundary of the regional area.	✓	✓
Mackerel Managed Fishery	Near surface trolling from vessels landed 288.8 tonnes of mackerel in 2013 from 13 boats across the three management areas (Kimberly, Pilbara and Gascoyne/South Management Areas.) The majority of the catch occurs in the Kimberly region (DoF 2014), outside the operational and regional areas.	✓	✓
Pilbara Demersal Scalefish Fishery (Pilbara Trap Managed Fishery; Pilbara Fish Trawl Interim Managed Fishery; Pilbara Line Fishery)	Commercially, a total of 1,074 tonnes of demersal scalefish were landed by trawl in 2013; 339 tonnes were landed by trap fishery and line fishery landed 85 tonnes. An additional 26.7 tonnes of demersal scalefish were landed by recreational fishery in the same year. Trawling has not been permitted in either Area 3 or Area 6 since 1998 (DoF 2014). The operational and regional area overlaps with Pilbara trap fishing effort only. There is a possibility this fishery may be active in the region; therefore licences were requested for individual fishers from the Pilbara line, Pilbara trap and Pilbara trawl for postal consultation. During consultation with Fat Marine (Pilbara Line Fishery license holder), activity within the operational area year round was confirmed.	✓	✓
Abalone Managed Fishery	In 2013 a total of 202 tonnes of greenlip/ brownlip abalone were caught commercially, and an estimated 8 tonnes were collected through recreational fishing (DoF 2014). 73 tonnes of Roe's abalone were landed commercially in 2013, of which 36 tonnes were landed on the west coast. 34 tonnes were landed recreationally, of which 20 tonnes were landed on the west coast (DoF 2014). Abalone is caught by divers (commercially) or wading and snorkelling (recreational), with the main effort concentrated south of Shark Bay which does not overlap with operational or regional area).	✓	✓
Marine Aquarium Fish Managed Fishery	A total of 19,302 fish (223 different species) were caught commercially in 2013. Primarily dive based fishery using hand-held nets. There is no documented recreational fishery. Popular areas are Exmouth and Dampier (DoF 2014), which fall outside the operational and regional areas. There is a possibility this fishery may conduct diving in the regional area; therefore licences were requested for individual licence holders within this	✓	✓

Aspect/feature	Description of presence/ activity	OA	RA
	fishery for postal consultation.		
South West Coast Salmon Fishery	93 tonnes of salmon were commercially landed in 2013 from two vessels. Recreation salmon fishing is popular by line fishing off a beach, though catch levels for 2013 are unknown (DoF 2014). All effort was south of Kalbarri, with concentrated effort off the south coast, and did not overlap the operational or regional areas.	✓	✓
Specimen Shell Managed Fishery	8,896 shells were collected commercially in 2013 usually by hand using a small group of divers in shallow coastal waters. Some shells were collected using remote controlled underwater vehicles at depths between 60 – 300 m. Recreational catch efforts for 2013 is unknown. While the fishery covers the entire WA coastline, concentration of effort is adjacent to population centres such as Karratha and Shark Bay and did not overlap the operational or regional areas in 2013 (DoF 2014).	✓	✓
West Coast Deep Sea Crustacean Managed Fishery	Using pots in a long-line formation, the fishery occurs in shelf edge waters (>150 m) along the Gascoyne coast to the NT boarder. 139.5 tonnes of crab were commercially landed in 2013. No recreational catch was recorded for 2013 (DoF 2014). Areas of fishing effort are unknown. There is a possibility this fishery may be active in the regional area; therefore licences were requested for individual licence holders within this fishery for postal consultation.	✓	✓

2.9.2 Tourism and Recreation

A summary of tourism and recreation within the operational area and regional area is provided in Table 12.

Table 12: Summary of tourism and recreation

Aspect/feature	Description of presence/ activity	OA	RA
Recreational fishing (beach)	Fishing from recreational crafts is very popular in the Exmouth and beach fishing commonly occurs throughout the region, including some of the tidal creeks. Queenfish, emperor, trevally, as well as whiting, bream and garfish are commonly caught. The waters of the Ningaloo Marine Park (MP) support extensive recreational fishing activities all year round	×	✓
Recreational fishing (offshore)	The game fishing season extends from late October to early February, but can occur all year round. Target fish include shark, marlin, mackerel, tuna, sailfish and dolphin fish. Fishing charters also commonly visit reef areas around the islands in state waters to fish for species such as red emperor, northwest snapper, cod, trevally and coral trout.	✓	✓
GAMEX (game fishing tournament)[1] and other fishing tournaments	The largest fishing event in Australia attracting 250-300 anglers for 9 days of activities, including 6 days of game fishing, held out of Exmouth in March each year. The event in 2016 will be held between 11 and 19 March; and the event in 2017 is expected to be held for a similar duration during March in 2017 and 2018. Over 30 game fish species are caught and entrants include state, national and international participants. Surveys estimate that the event generates approximately $2 million in revenue for the community of Exmouth (GAMEX 2015).	×	✓

1 The stakeholder engaged for GAMEX is the Exmouth Game Fishing Club.

Aspect/feature	Description of presence/ activity	OA	RA
	Other WAGFA sanctioned fishing tournaments are also planned during 2016 in the RA.		
Humpback whale / whale shark watching and swimming tours	Specialised 'eco-tourism' activities include whale watching, whale shark and manta ray observation, and whale/ whale-shark swimming. Whales transit the coast twice a year on their northern then southern migrations. In 2016, new licenses are available for humpback whale watching and swimming tours, in a trial two year basis. Whale shark aggregate around Ningaloo NP between March and July, with stakeholders suggesting that whale shark watching and swimming tours are typically held between March and September. Licenses for humpback whale watching and swimming tours extend the current whale shark license until October for all existing license holders. Manta rays tours run off Ningaloo between March and April.	✓	✓
Turtle tours	Visitors are able to view marine turtles nesting on beaches just 13 km from Exmouth, with tours run from November to February each year. The tours are run from the Jurabi Turtle Centre, located between Hunters and Mauritius beaches, adjacent to a popular rookery for three marine turtle species: green, loggerhead and hawksbill.	×	✓
Ecotours and safaris	Apart from the tours listed above, ecotours also occur all year round which view dolphins, dugongs, sharks and fish as well as coral and general scenery.	×	✓
Diving and snorkelling	The Ningaloo MP supports extensive scuba diving and snorkelling activities particularly inside the coral lagoons of the Ningaloo Reef system. Many diving, snorkelling and glass bottom boat tours run throughout the year, with peak periods during the April and July school holidays. Stakeholders revealed that expected diving season around the Muiron Islands is between April and October.	×	✓
Recreational boating, sailing and kayaking	These activities occur all year round and are concentrated in the vicinity of the population centres such as Exmouth and Onslow.	✓	✓

2.9.3 Aquaculture

A summary of aquaculture interest within the operational area and regional area is provided in Table 13.

Table 13: Summary of aquaculture interests

Aspect/feature	Description of presence/ activity	OA	RA
Pearl farming	Aquaculture in the region is dominated by the production of pearls and pearl oysters in the major embayments. Hatcheries in Exmouth supply significant quantities of pearl spat (*Pinctada maxima*) to pearl farms in Exmouth Gulf and the Montebello Islands (Carnarvon Basin). There is also a developing industry based on blacklip pearl oyster *Pinctada margaritifera*.	×	✓

2.9.4 Cultural heritage

There are no known Indigenous cultural heritage values or issues for the waters and seabed within or in the vicinity of the survey area or zone of potential influence (ZPI).

Details of recorded shipwreck sites are available on the Australian National Shipwreck Database are managed by the Department of the Environment (DotE). Under the Commonwealth Historic Shipwrecks Act, 1976 all shipwrecks older than 75 years are protected. A search of the database revealed three heritage protected wrecks are located outside the operational area, but within the regional area.

2.9.5 Shipping

Australian Maritime Safety Authority (AMSA) has established a network of Shipping Fairways off the north-west coast of Australia designed for keeping shipping traffic away from offshore infrastructure and aims to reduce the risk of collision (AMSA 2012). The operational and regional area intersects two shipping fairways that operate generally in a north south direction to the coast.

2.9.6 Defence

Royal Australian Air Force (RAAF) Learmonth base is located on the NWC at Cape Range and is a significant Australian Defence Force (ADF) facility and Regional Force Surveillance Unit Depot / Patrol Base. The area around the base is classified as an Air to Air Weapons Range where military flying and military flying training activities may occur (DoD 2011).

The Department of Defence (DoD) has advised that unexploded ordnance (UXO) could be present on and in the sea floor in the area of the propose activity.

2.9.7 Petroleum activities

A summary of petroleum operators with interests in the operational area is provided in Table 14.

Table 14: Summary of Petroleum Interests within the operational area

Petroleum Operator	Relevant Petroleum Titles	Offshore Petroleum safety zones (infrastructure)
Petroleum Interests		
BHP Billiton Petroleum (Australia) Pty Ltd & BHP Billiton Petroleum (North West Shelf) Pty Ltd	Exploration Permits: WA-255-P; WA-335-P; WA-351-P; WA-475-P Production Licences: WA-10-L; WA-12-L; WA-32-L; WA-42-L; WA-43-L	Pyrenees Venture Floating Production Storage and Offloading (FPSO) facility
Chevron Australia Pty Ltd	Exploration Permits: WA-205-P; WA-253-P; WA-268-P; WA-367-P; WA-374-P; WA-383-P; WA-392-P; WA-444-P; Retention Leases: WA-14-R; WA-15-R; WA-19-R; WA-20-R; WA-21-R; WA-22-R; WA-23-R; WA-24-R; WA-42-R; WA-53-R; WA-60-R Production Licences: WA-36-L; WA-37-L; WA-38-L; WA-39-L; WA-40-L Access Authority: WA-81-AA	-
Hess Australia (Offshore) Pty Ltd & Hess Exploration Australia Pty Ltd	Exploration Permits: WA-390-P; WA-474-P; WA-518-P; WA-519-P	-
Quadrant Northwest Pty Ltd, Quadrant Oil Australia Pty Ltd, Quadrant Permits Pty Ltd, Quadrant PVG Pty Ltd	Retention Lease: WA-49-R; WA-59-R Exploration Permits: WA-155-P; WA-214-P; WA-290-P; WA-320-P; WA-486-P; Production Licence: WA-35-L; WA-45-L; WA-55-L	Ningaloo Vision Floating Production Storage and Offloading (FPSO) facility
Woodside Burrup Pty Ltd & Woodside Energy Ltd	Retention Leases: WA-36-R Exploration Permits: WA-271-P; WA-358-P; WA-428-P; WA-430-P; WA-461-P; WA-463-P; WA-478-P; WA-483-P	Nganhurra Floating Production Storage and Offloading (FPSO) facility Ngujima-Yin Floating Production Storage and

Petroleum Operator	Relevant Petroleum Titles	Offshore Petroleum safety zones (infrastructure)
	Production Licence: WA-28-L Access Authority: WA-82-AA	Offloading (FPSO) facility

3 Detail of Stakeholder Consultation

3.1 Overview of stakeholder strategy

Stakeholder consultation is an essential part of project planning, and SLB recognises that effective stakeholder consultation and engagement is critical to project success. To meet and address its obligations under the OPGGS(E) Regulations, SLB has developed an inclusive and ongoing consultation process. The objectives of this process are:

- to ensure that "relevant persons" (as defined in Regulation 11A(1) of the OPGGS(E) Regulations) are provided with "sufficient information" to allow an informed assessment to be made, and an adequate opportunity ("reasonable period") to consider and provide feedback
- to provide a mechanism for assessing the merit of any objections or claims received
- to demonstrate that control measures (where applicable) that have been adopted as a result of the outcome of consultation are appropriate
- to support ongoing stakeholder identification and consultation
- to demonstrate to the regulator that ongoing consultation is meeting the objectives of the OPGGS(E) Regulations.

3.2 Consultation during Preparation of the EP

3.2.1 Consultation Pack

Following identification of relevant persons, SLB contacted all stakeholders to provide them with a Consultation Pack. Initial consultation packs were sent in August 2015; this information was subsequently made available to newly identified stakeholders as the process progressed.

The pack provided the following information:

- Location map and bounding co-ordinates of the MSS operational area
- High level information on the nature of the planned activity
- How to provide feedback, and contact detail to which relevant persons can provide comment on the proposed activity.

All stakeholders were encouraged to engage, and invited to provide comment or request additional information if required.

3.2.2 First Update

An update letter was sent to all relevant persons in February 2016. The letter was written to provide an update on the project, specifically regarding the revised operational schedule of the MSS.

Through this update, SLB also sought further information from stakeholders regarding the temporal and spatial extents of stakeholder activities in relation to the planned operational area.

3.2.3 Second Update

An update letter was sent to all relevant persons in May 2016. Following operational decisions changing the survey timing (now to be undertaken at any time between September 2016 and September 2018), a minor extension to the survey operational area on the eastern boundary and confirmation of the southern exclusion area, SLB took additional time to review the stakeholder consultation undertaken to date and to consider appropriate controls for the revised project.

3.2.4 Consultation with Petroleum Operators

In order to identify Petroleum Operators with a potential stake in the activity, Petroleum Titles / Instruments were considered during the stakeholder identification process. All title holders were provided with an Access Authority (AA) form in October 2015, detailing the survey parameters and requesting permission for access to permitted areas. Following this, a consultation meeting was held with all interested parties. In this meeting, SLB detailed the operational area, survey timings and duration,

and discussed the possibility of any conflicts with titleholder operations in permit area. All titleholders were provided with the consultation pack (See Section 3.2.1).

In addition to consultation with titleholders, SLB reviewed submitted and accepted EPs on the NOPSEMA website to determine if other planned operations (such as multi-client seismic surveys) have potential for spatial or temporal overlap with the planned MSS. Operators of any such surveys were notified of the activity via email and provided with the consultation pack.

On 22nd July 2016 SLB sent a letter to update all relevant Petroleum Operators; detailing the change in survey timing and a minor extension to the survey operational area, and confirming the southern exclusion area. Limited responses were received from relevant Petroleum Operators and consultation is ongoing.

3.3 Consultation Response and Merit Assessment

All feedback received from stakeholders was responded to in writing, confirming that SLB was aware of any concerns raised, providing responses and presenting any planned management/ control measures proposed to reduce impacts and risks.

Where merited responses were provided by stakeholders, SLB has considered the risk associated and incorporated appropriate control measures within the EP. Where no comment was received, SLB sent a follow-up email or letter further inviting feedback.

Table 15 and Table 16 present the consultation summary and merit assessment for stakeholders engaged during the preparation of the EP. SLB will continue to engage with stakeholders, both in relation to the most recent project updates and following EP acceptance during the lead up to commencement of the survey, throughout the survey and on completion.

Table 15: Summary of Consultation Already Undertaken and Merit Assessment

Stakeholder	Engagement by SLB		Response from Stakeholder		SLB Merit Assessment and Action / Response
	Consultation Type	Date	Date	Stakeholder Response	
Government and Authorities					
Australian Hydrographic Service (AHS)	Consultation Pack – comprising information in Second Update	18/05/16	19/05/16	Acknowledged receipt of email and thanked SLB.	SLB commits to ongoing consultation with this stakeholder as per Section 3.4.
Australian Fisheries Management Authority (AFMA)	Consultation Pack	28/08/15	07/09/15	Acknowledged receipt of consultation and directed SLB to AFMA website	Email (09/09/15) - SLB confirmed consultation with Commonwealth Fisheries Association, the West Australian Fishing Industry Council, WA Department of Fisheries and Recfishwest.
	Telephone Call	12/11/15	-	SLB contacted AFMA to discuss representation of Commonwealth fisheries and whether it is necessary to contact individual fisherman. AFMA advised if their guidelines are followed then additional consultation is not required.	-
		-	12/12/15	Email: Confirmation that SLB did not need to contact individuals of WTBF.	-
	Telephone Call	29/02/16	-	SLB requested details of one outstanding fisher. These were provided by AFMA.	-
	First Update	07/03/16	-	No response	-
	Second Update	18/05/16	-	-	SLB commits to ongoing consultation with this stakeholder as per Section 3.4 and control measures described within Table 20.
Australian Maritime Safety Authority (AMSA)	Consultation Pack	28/08/15	31/08/15	Co-ordinates requested in different format	Email (02/09/15) – coordinates provided in requested format.
			03/09/15	AMSA provided shipping traffic plots, and advised of potential for vessel traffic in region noting shipping fairways. Vessel must display safety gear and implement appropriate watch. Pre-activity notifications to be sent to AMSA's JRCC before operations commence (including vessels details and dates when the survey starts and ends). AHS must be contacted no less than 4 working weeks before operations commence for the promulgation of related Notices to Mariners. AMSA requested SLB provided comment on the operations and the interaction with commercial shipping at the time of the survey (i.e. any lessons learned).	Email (07/09/15) – SLB Confirmed AMSA requests will be adhered to. SLB will adhere to request provided by AMSA. Appropriate control measures have been defined (see Table 20), including: • Compliance with Marine Orders Part 30: Prevention of Collisions (Issue 8) and Part 21: Safety of navigation and emergency procedures (Issue 8) specifically, use of standard maritime safety procedures (including radio contact, display of navigational beacons and lights). • Consultation with AMSA to ensure that warnings are issued to mariners in a timely manner; and post survey consultation with AMSA ensures that the Industry is aware of lessons learnt based on experiences during the actual activity. • Notices to mariners are issued detailing planned survey vessel operations.
	First Update	07/03/16	08/03/16	New traffic plot provided Traffic has increased in density since the last image was supplied in June Re-iterated previous requirements.	Information incorporated into the EP (Section 4.3.5)
	Second Update	18/05/16	23/07/16	AMSA stated that previous advice provided by AMSA on the 8 of March 2016 remains extant and provided an updated AIS traffic plot for the survey area based off of data from April 2016. AMSA stated that they were pleased to see that previous feedback has been acted upon and SLB have taken steps to address previously mentioned maritime safety advice.	The commercial shipping fairways within the operational area are based on hourly vessel location information provided by AMSA in February 2016. The hourly vessel location information provided by AMSA for April 2016 does not present any significant change in shipping density or shipping fairways to that already presented in Figure 7 of the EP based on data provided by AMSA in February 2016. SLB commits to ongoing consultation with this stakeholder as per Section 3.4 and control measures described within Table 20.
Conservation and Parks Commission, Government of WA	Consultation Pack – comprising information in Second Update	18/05/16	20/06/16	Acknowledged receipt of email and thanked SLB. Requested that SLB add the email address info@conservation.wa.gov.au to their client update list.	SLB commits to ongoing consultation with this stakeholder as per Section 3.4. The email address info@conservation.wa.gov.au will be used to issue updated stakeholder information to Conservation and Parks Commission, Government of WA.

Stakeholder	Engagement by SLB		Response from Stakeholder		SLB Merit Assessment and Action / Response
	Consultation Type	Date	Date	Stakeholder Response	
Department of Defence	Consultation Pack	28/08/15	16/09/15	No objections to the activity. Requested pre-activity notifications to the AHS and Joint Airspace Control Cell (JACC).	SLB commit to undertaking pre-activity notifications to AHS and JACC (see Table 20).
	First Update	07/03/16	-	No response	There remains the possibility that the operations may overlap with military flying and training activities. This will be identified through JACC pre-activity notifications; and managed through SLB's stakeholder strategy.
	Second Update	18/05/16	-	-	In the second update SLB addressed the concerns raised by the DoD requesting pre-activity notifications to be provided to the JACC and AHS. SLB will carry out ongoing consultation with the DoD to ensure that the activities are effectively managed to coincide with other potential DoD activities and has developed appropriate control measures in Table 20, including appropriate notifications at least four weeks prior to the commencement of the survey to the AHS and JACC.
	Telephone Call	19/05/16	-	SLB explained the context of the update, and briefly described the changes. DOD confirmed that there would be no change in feedback from the advice previously sent, and all notifications as per the feedback will remain.	SLB commits to ongoing consultation with stakeholders as per Section 3.4 and control measures described within Table 20.
Department of Fisheries (DOF)	Consultation Pack	28/08/15	-	-	-
	Follow-up email	31/08/15	02/09/15	SLB requested individual fishing license holder contact details (via email, and then via online submission as requested) DoF licensing department provided SLB with lists of individual licence holders in the requested fisheries.	SLB has consulted with all individual licence holders provided by DoF.
			17/09/15	Risks and impacts to fish spawning aggregation times Biosecurity Reporting on potential spills DoF recommend that consultation occur with fishing representative bodies including WAFIC, Recfishwest, the Pearl Producers Association.	Email (28/09/15) - SLB responded to consultation addressing each of the key issues raised by DoF and appropriate control measures have been included in Table 20. SLB confirms that recommended consultations have already been undertaken.
	Update on activity timings (Email)	24/02/16	02/03/16	Reiterated previous advice.	-
	Follow-up Call	26/02/16			
	Second Update	18/05/16	06/07/16	Acknowledged receipt of email and thanked SLB. Previous advice remains valid; however given the change in timing other key spawning times will need to be considered. DOF attached the Departments "Guidance statement on undertaking seismic surveys in Western Australian waters" and advised its review for other key spawning times. DOF attached the 'Status Reports of the fisheries and aquatic resources of Western Australia 2014/15 'and recommended that the document and other published literature available on the website be reviewed to further identify sensitive locations and timings relevant to the survey operations.	The Department's Status reports of the fisheries and aquatic resources of Western Australia 2014/15 has been reviewed and referenced within Section 4.3.1 of the EP and Section 2.9.1 (Table 11) of this EP Summary. Spawning year-round is considered in the EP. Table 22 of the EP provides details of year round spawning for various species (from the Gascoyne Region), this information is taken from "Guidance statement on undertaking seismic surveys in Western Australian waters" previously communicated by DOF to SLB. SLB commits to ongoing consultation with this stakeholder as per Section 3.4 and control measures described within Table 20.
Department of Mines and Petroleum (DMP)	Consultation Pack	28/08/15	02/09/15	DMP requested information regarding activity operating along State boundaries. SLB advised to: avoid State Marine Reserves; and consider whale migration and other users. DMP requested information in regards to major environmental hazards and mitigations.	Email (02/10/15) – SLB provided information requested.
	First Update	07/03/16	-	No response	-
	Second Update	18/05/16	10/06/16	Acknowledged receipt of email. No additional comments at this stage	In the second update SLB addressed the concerns raised by the DMP. Seasonal exclusion zones will be implemented to reduce the potential for disturbance to migrating whales and whale sharks (see Figure 2). Appropriate control measures will be implemented as described in Table 20 to avoid or minimise disruption to other marine users, for example SLB will advise diving operators (tourism and fishing) of the dynamic 10 km diving exclusion zone around the seismic vessel and seek to resolve any conflicts raised by consultees.

Stakeholder	Engagement by SLB		Response from Stakeholder		SLB Merit Assessment and Action / Response
	Consultation Type	Date	Date	Stakeholder Response	
					SLB commits to ongoing consultation with this stakeholder as per Section 3.4 and control measures described within Table 20.
Department of Parks and Wildlife (DPaW)	Consultation Pack	28/08/15	11/09/15	Telephone - DPaW confirmed that they have no objections to petroleum industry activities as long as the EP is written to the satisfaction of the regulator.	-
			15/09/15	DPaW questioned whether the operational area of the survey would impact nearby marine parks, and noted the Ningaloo Coast WHA was not listed in the inventory of key regional features. DPaW requested the following to be considered in the EP: • Seasonal sensitivities for all species Specially Protected under the Wildlife Conservation Act 1950 or have been listed as Priority Species by the Department of Parks and Wildlife; • Underwater noise assessment, specifically relating to Specially Protected and/or Priority Species; • Management/ design of survey to avoid or minimise impacts to Specially Protected and/or Priority Species; • Protection of environmental and social values within relevant Management/ Conservation plans; and • Cumulative Impacts.	Email (17/09/15) – SLB commits to addressing each of the key issues raised. Seasonal sensitivities for all protected species and environmental and social values for the operational and regional areas are provided in Section 2 of this EP Summary. SLB has undertaken a comprehensive underwater noise assessment (see Section 4.4) which includes addressing the potential for cumulative impacts with other planned seismic surveys either approved or submitted for assessment. Specific control measures have been incorporated into the design and management of the survey (see Section 1.3 and Table 30).
	Telephone	11/11/15	-	SLB requested list of operating tourism industry operators. DPaW agreed to assist, and suggested a request be made in writing.	Email (13/11/15) – SLB requested DPaW provide details of local tourist operators operating in the Exmouth region.
	-	-	17/11/15	DPaW licensing department provided a list of local tourism operators.	SLB has consulted with all local tourism operators provided by DPaW.
	First Update	07/03/16	-	No response	-
	Second Update	18/05/16	-	No response	In the second update SLB addressed the concerns raised by DPaW in their consultation responses to date. SLB will implement control measures described in Table 30 which include implementation of seasonal exclusion zones to reduce the potential for disturbance to migrating whales and whale sharks (see Figure 2); EPBC Policy Statement 2.1 management measures; and additional adaptive management measures. SLB commits to ongoing consultation with this stakeholder as per Section 3.4.
	Telephone	14/06/16	-	DPAW informed SLB that one of their members had tabled the upcoming survey on their meeting agenda.	-
	Telephone	24/06/16	-	DPAW indicated in a phone conversation that there were no issues in relation to the changes provided in the May 2016 consultation pack.	SLB commits to ongoing consultation with this stakeholder as per Section 3.4 and control measures described within Table 30.
DPaW Exmouth	Consultation Pack	28/08/15	04/09/15	Telephone - DPaW Exmouth confirmed they will contribute to consultation via DPaW's head office and would not be providing regional consultation from the Exmouth DPaW branch. Requested that information be forwarded to Ningaloo Coast World Heritage Advisory Council (NCWHAC).	SLB has consulted with NCWHAC (see below).
	Telephone call	18/07/16	-	Phone conversation with Department of Fisheries (Exmouth) regarding rock lobster catch and fishing at North West Cape in which they explained that no commercial rock lobster fishing occurred out of Exmouth and there is no catch at North West Cape / Ningaloo reef. Department of Fisheries (Exmouth) explained that the nearest commercial rock lobster vessels operate out of Geraldton and Kalbarri and may go as far north as Shark Bay, within Zone B catch area.	SLB removed West Coast Rock Lobster Managed Fishery as a relevant person.
Department of Transport (DOT)	Consultation Pack	28/08/15	18/09/15	Telephone – DOT confirmed seismic vessels are viewed the same as all vessels in terms of spill response.	-
	First Update	09/03/16	-	No response	-
	Second Update	18/05/16	-	DOT confirmed receipt of the consultation pack and passed it on to the relevant officer.	SLB commits to ongoing consultation with this stakeholder as per Section 3.4 and control measures described within Table 20.

Stakeholder	Engagement by SLB		Response from Stakeholder		SLB Merit Assessment and Action / Response
	Consultation Type	Date	Date	Stakeholder Response	
Ningaloo Coast World Heritage Advisory Council (NCWHAC)	Consultation Pack	04/09/15	12/09/15	Following points recommended for consideration, to minimise environmental impacts on world heritage values: Survey timing to avoid peak times of year for whale shark aggregations and humpback whale migration Cumulative impacts	SLB will implement control measures described in Table 30 which include implementation of seasonal exclusion zones to reduce the potential for disturbance to migrating humpback whales and whale shark (see Figure 2).
	First Update	09/03/16	-	-	-
	Second Update	18/05/16	-	-	In the second update SLB noted the following concerns raised by the NCWHAC in their responses to date and provided a list of control measures that will be implemented to address survey timing during whale shark aggregations and potential for cumulative impacts with other seismic surveys (see Table 30). SLB commits to ongoing consultation with this stakeholder as per Section 3.4.
Shire of Exmouth Council	Consultation Pack	28/08/15	-	No response	-
	First Update	07/03/16	11/03/16	Telephone – Shire of Exmouth Council recommends use of the 'Exmouth Info' website for activity notification.	SLB commit to posting notification on the website and community notice board.
	Second Update	18/05/16	-	-	In the second update SLB confirmed that an activity notice will be provided at a strategic location to ensure that recreational users have an additional avenue for activity awareness (in addition to navigational warnings and AusCoast warnings). (refer to the control measure described within Table 20). SLB commits to ongoing consultation with this stakeholder as per Section 3.4 and control measures described within Table 20.
Organisations and Industry Representatives					
Australian Marine Oil Spill Centre (AMOSC)	Consultation Pack	28/08/15		No response	-
	Telephone	08/03/16		AMOSC confirmed that no review of the OPEP is required.	-
	Second Update	18/05/16			SLB commits to ongoing consultation with this stakeholder as per Section 3.4 and control measures described within Table 20.
Cape Conservation Group (CCG)	Consultation Pack	28/08/15	29/08/15	Further information requested on environmental mitigations factors; advising consideration be taken to cumulative impacts and requesting consultation also be carried out with the World Heritage Advisory Committee.	**Email (09/10/15)** - Further clarification of the information in the EP provided to CCG.
			29/10/15	CCG request clarification of which seasonal events SLB has addressed in the EP; and details of the mitigation factors in place for humpback whales, marine turtles (migration, nesting and hatching), whale shark, and pygmy blue whale. CCG also requested information on how the 500m buffer zone with the World Heritage Area was decided and the supporting evidence this buffer zone is adequate.	**Email (01/12/15)** - Initial key EP control measures were provided to CCG (via email 01/12/15) addressing concerns regarding mitigation factors and WHA buffer zone.
	Telephone	03/12/15		CCG confirmed this level of information was sufficient to make an assessment on the activity.	-
	-		20/12/15	CCG expressed concerns about the open time-frame in relation to the south-eastern section in the depths of 200m or less. A brief outline of the key areas they expressed concerns are: • proximity to the Ningaloo Coast World Heritage Area • known use of the area by protected species • shallow water depth • cumulative impacts of concurrent, consecutive or seasonally-consecutive seismic operations • proximity to Cape Range sub-sea canyon system contained within the Gascoyne Marine Reserve CCG made the following recommendations:	**Email (23/12/15)** - SLB provided CCG with control measure updates including: PAM would not be used for advising on shutdowns as it was considered unreliable in estimating distance from vocalising cetaceans. The geofence referenced previously was a measurement criteria and not a performance standard. The previously described EPS limiting SLB to 16 hours in the areas adjacent Ningaloo WHA would be removed; The EP will describe the values of relative management plans and activities consistent with these values SLB will acquire the four closest sail lines (acquisition on pre-planned survey lines) that will run parallel and adjacent to the protected areas (>500m from) from May through June 2016. SLB's acknowledged CCG's concerns by responding to CCG's recommendations. The response below was based on survey planning at that time (note it was subsequently updated – see further information sent to CCG in the second

Stakeholder	Engagement by SLB		Response from Stakeholder		SLB Merit Assessment and Action / Response
	Consultation Type	Date	Date	Stakeholder Response	
				• The survey is not conducted during turtle migration or nesting, or hatching seasons near within the vicinity of the Muiron islands. • Use of a spotter plane for detection of whale sharks visualise whales, whale sharks and turtles when conducting surveys in less than 200m of water in the south eastern section of your survey. • Literature is consulted to establish distance at which fish are not impacted by seismic noise from the activity. • Consider cumulative impacts from the proposed activities. • The survey does not include the areas over the Northern subsea Cape Range sub-sea canyons.	update on the 18/5/2016) • All phase 1 acquisition (the southern campaign) within the 400m bathymetry depth will be acquired prior to September 2016. This avoids the peak of the turtle nesting periods in the southern part of the operational area adjacent the Muiron Islands. Note: this was later found to not be feasible with the implementation of further temporal zoning controls to minimise impacts to more sensitive cetacean receptors. • A spotter plane was not committed at the time (see also response on 24/02/2016); • SLB committed to include an assessment of risk described in literature for fish relative to the activity noise. This was completed (see Section 4.4.2.7). Note modelling was also conducted for this purpose. • SLB will include an assessment of cumulative impacts (see 4.3.2.7); • The proposed activity will largely avoid the Cape Range sub-sea canyon system and the overlap was found to have an acceptably low level of risk to the environment of the canyons.
	-		03/01/16	Further information requested in relation to risks associated to pygmy blue whale and whale sharks, especially in areas potentially important feeding grounds. The mitigation factors for whale sharks do not appear to address visualisation of whale sharks. CCG suggests an alternative time frame or aerial observations incorporated into shutdown controls for whale sharks. CCG query if drones would be of benefit to the activity.	SLB provided key controls applicable to mitigate risks to whale sharks (via email 19/01/16)
	-		25/01/16	CCG outlined concern around feeding grounds for pygmy blue whales and whale sharks.	**Email (24/02/16)** – SLB provided an updated timing and the following commitments: The acquisition of the sail line within the pygmy blue whale foraging area as well as approximately four adjacent lines (north of the possible foraging area) ensures that an area of approximately 3 km from marine protected areas in the southeast will be acquired in June to reduce the risk of peak migration periods for whale sharks and blue whales (this water revised in follow up consultation) Schlumberger will not undertake acquisition south of Latitude -21.67. No spotter plane committed, however SLB will work with tourism operators to receive data from whale shark spotter planes if these are within the region and if the tourism operator agrees to provide this information. SLB commit to using one vessel as an additional sighting platform ahead of the survey vessel during May through July, when the risk of encountering a whale shark is considered most likely and coinciding with migratory behaviour There were limited proven commercial applications of drones for SLB to commit to these SLB outlined ongoing consultation commitment (consistent with consultation strategy)
	Second Update	18/05/16	-	-	In the second update SLB further addressed all the relevant concerns raised by CCG in all previous responses in terms of the latest survey plan. SLB has undertaken a comprehensive assessment of the potential impacts and risks associated with the activity and advised CCG that with the implementation of appropriate control measures (see Table 30), underwater noise from operation of the seismic source will not result in a potential impact greater than minor disruption to a small proportion (individuals) of marine fauna populations, and no impact on critical activities. In addition, there are no predicted long-term effects at a population level, and no adverse effects on the environmental values of protected areas or biologically important areas. The control measures in Table 30.have been developed in consideration of the concerns raised by CCG. SLB commits to ongoing consultation with this stakeholder as per Section 3.4 and control measures described within Table 30.
Exmouth Visitors Centre (EVC)	Consultation Pack	28/08/15	-	No response	
	Telephone	11/11/15	-	Telephone - EVC was contacted by phone to discuss consulting with local tourism operators. EVC offered advice for SLB to focus on contacting Whale Shark Tour Operators, Glass Bottom Boats and Sail Ningaloo.	**Email (12/11/15)** –SLB provided EVC with a list of contact details for tourism operators after confirming the list previously provided by DPaW was adequate (refer to transcripts for full list).

Stakeholder	Engagement by SLB		Response from Stakeholder		SLB Merit Assessment and Action / Response
	Consultation Type	Date	Date	Stakeholder Response	
	-		20/11/15	EVC responded with a full list of contact details for the stakeholder list provided	SLB acknowledges receipt, and included all stakeholders provided into consultation process
	First Update	24/02/16	-	No response	-
	Second Update	18/05/16	-	-	In the second update SLB advised the EVC of the control measures that will be implemented to address concerns raised by local tourism operators (see Table 30). SLB commits to ongoing consultation with this stakeholder as per Section 3.4.
International Fund for Animal Welfare (IFAW)	Telephone	11/11/15	-	An SLB representative introduced the proposed activity to this stakeholder in phone consultation. IFAW requested a consultation package.	-
	Consultation Pack	12/11/15	23/11/15	IFAW requested additional information in relation to the operational times.	**Email (01/12/15)** – SLB provided further clarification of survey timings. In addition, SLB provided IFAW with a table of key controls related to minimising impact to protected species.
	-	-	02/12/15	IFAW requests results of modelling when it is complete, to gain understanding of the likely risks to whales in sensitive areas.	**Email (17/12/15)** – SLB provided summary of noise modelling results. In addition SLB provided the following control measure: SLB will acquire a minimum of four (4) sail lines (survey acquisition on pre-planned survey lines) that will run parallel and adjacent to the protected areas (>500m from) prior to July 2016. Note: this has subsequently been updated and advised in second pack on 18/05/2016.
	Update on control measures	23/12/15	11/01/16	SLB provided IFAW with updates to control measures, including: PAM would not be used for advising on shutdowns as it was considered unreliable in estimating distance from vocalising cetaceans. The geofence referenced previously was a measurement criteria and not a performance standard. The previously described EPS limiting SLB to 16 hours in the areas adjacent Ningaloo WHA would be removed; IFAW disputed the removal of the PAM enforced shutdowns. IFAW recommended the PAM controls for enforcing shutdown are reinserted, at the very least for sperm whales in particular.	**Email (07/03/16)** - SLB provided IFAW further details regarding PAM reliability. IFAW were advised that PAM operators where being consulted so that SLB will re-introduce PAM controls to also be used to trigger shutdowns, where vocalisations can be validated within the shutdown zone with an appropriate level of confidence.
	Second Update	18/05/16	-	-	In the second update SLB addressed the concerns raised by DPaW in their consultation responses to date. SLB will implement control measures described in Table 30 regarding the use of PAM during the survey: • PAM will be implemented on the seismic vessel at night and during periods of poor visibility when the acoustic source is operational. • A trained and experienced PAM operator will be engaged for the duration of the survey. • The PAM system capability will have the capacity to receive vocalisation of whales within the frequencies (4Hz – 180kHz +/-3dB). • During daylight hours PAM detections will be validated against MFO observations and ranges in order to determine the error (if any) in PAM detection distances. • If PAM records prove reliable in estimating distances, then PAM will be used to trigger low power and shut-down procedures at night and during periods of poor visibility. • If PAM records are shown to be inaccurate in estimating distances, the seismic vessel will power-down in the event of a confirmed detection (comprising 3 or more detection records for an individual whale) and not power-up until 30 minutes has passed without another detection. SLB commits to ongoing consultation with this stakeholder as per Section 3.4 and control measures described within Table 30.
TOLL Exmouth	Consultation Pack	28/08/15	15/09/15	Requested the names of the seismic vessel and support vessels that will be conducting MSS surveys out from	SLB acknowledges the requested and commits to providing this detail (committed to stakeholder via email 15/09/15).

Stakeholder	Engagement by SLB		Response from Stakeholder		SLB Merit Assessment and Action / Response
	Consultation Type	Date	Date	Stakeholder Response	
				Exmouth (post EP acceptance).	
	First Update	07/03/16	-	No response	-
	Second Update	18/05/16	-	-	SLB commits to ongoing consultation with this stakeholder as per Section 3.4 and control measures described within Table 20.
Western Australian Fishing industry Council (WAFIC)	Consultation Pack	18/05/16	23/05/16	Acknowledged receipt of email and thanked SLB. WAFIC requested a meeting with SLB to discuss concerns etc.	SLB acknowledged that all future correspondence to WAFIC should be made via the email address eora@wafic.org.au. A meeting was organised between SLB and WAFIC (scheduled for 16 June 2016).
	Meeting held between SLB and WAFIC.	16/06/16	-	WAFIC seek clarification on likelihood of activity and timing of the activity and have feedback from license holders concerned about the repeated activity in their areas.	SLB commits to ongoing consultation with all fishers stakeholders as per Section 3.4. During the meeting between SLB and WAFIC all concerns from WAIFIC and license holders were discussed and addressed. The following control measures will be implemented (Table 20): • SLB will manage interactions with other marine users through the use of a dedicated chase vessel. • Avoid overlapping concurrent seismic operations (to avoid the potential for cumulative impacts). • Notices to mariners are issued detailing planned survey vessel operations. • Ongoing consultation with relevant stakeholder will ensure that stakeholders have sufficient information to make an informed decision of the risks and re-assess impacts that the activity may present for their interest. • SLB will call relevant persons to consult on the potential for overlap with the MSS to manage and conflict that may arise.
Commercial Fishers					
Fat Marine	Consultation Pack	28/08/15	28/08/15	Fat Marine expressed strong and complete objection to the activity.	SLB notes Fat Marine objections (via email 09/09/15), and will work with affected fishers accordingly. **Email (19/11/15):** As no further response was received from Fat Marine, SLB re-engaged and requested details of locations and time of year that they are likely to fish inside the operational area.
			19/11/15	Operations could occur in the area from (redacted for confidentiality).	
	Meeting	08/12/15		Fat Marine requested a face-to-face meeting with SLB. Key items raised: • Fat Marine operates a Pilbara Line Fishery license. In 2016 Fat Marine intends to operate on 2.5 licenses to encompass 12 months of the year • Fat Marine will fish for (redacted for confidentiality). • Area of interest to Fat Marine extends from Exmouth region to (redacted for confidentiality) • Fat Marine is inherently against seismic as it negatively impacts the business. • Fat Marine noted fish were hearing their 2 kilowatt sounders and avoiding the area, assuming because the fish believe this is coming from a seismic vessel. • Fat Marine believes impacts of seismic are felt 10 miles from the source. • Fat Marine uses an app, 'searcher', to keep track of seismic vessel locations.	• SLB commits to avoiding any interaction/incidence with strong communication. Email (09/12/15) – Follow up email confirming SLB commits to high levels of consultation and will commence with a pre-activity notification at least 4 weeks prior to commencement of the activity and to maintaining 40 km from any adjacent seismic survey. Email (01/03/16) – SLB provided Fat Marine map showing other seismic activities in the region.
	First Update	24/02/16	-	-	-
	Second Update	18/05/16	-	-	In the second consultation update SLB addressed the concerns raised by Fat Marine. Fat Marine advised SLB of concerns around catchability of fish and that it believed fish could be affected up to 10 miles (~ 20 km) from a seismic source. However, modelling has shown that the relatively small airgun volume to be used in the Exmouth SLB15 MC3D MSS will only affect fish behaviour over a horizontal distance of approximately 600 m to 2.6 km from the active seismic source. Any effects on catchability will be temporary in any location as the seismic vessel traverses along each survey line. Further, the seismic vessel will not operate in shallow water or directly over shallow reefs where site-attached fish species occur, as the shallowest water depth that the vessel will operate is 30 m (which makes up a very small

Stakeholder	Engagement by SLB		Response from Stakeholder		SLB Merit Assessment and Action / Response
	Consultation Type	Date	Date	Stakeholder Response	
					proportion of the operational area), with the majority of data acquisition in >200 m water depth. Refer to Section 7.3 for a detailed assessment of noise impacts on fish and on fish catchability SLB commits to ongoing consultation with this stakeholder as per Section 3.4 and control measures described within Table 20 and Table 30.
Pearl Producers Association (PPA)	Consultation Pack	28/08/15	-	No response	-
	Telephone	11/09/15	-	The following details were discussed: PPAs main interest is in the vicinity of 80 Mile Beach; Currently no active pearling leases in this area. PPA requested an additional map with bathymetry contours to provide to members (see transcript in Appendix A); As long as this activity does not impact brood shell the PPA would not have a real concern; SLB advised to consider when spawning occurs to minimise impact on larvae; SLB advised to take into account brood stock may be up to 100 m water depth; SLB requested to minimise the exposure in shallow waters.	SLB have considered all points raised by PPA, and incorporated their concerns into the risk assessment. **Email (16/09/15)** - SLB provided PPA with a map showing the bathymetry in shallow waters and provided clarification that no activities would occur outside the operational area.
	First Update	24/02/16	-	No response	
	Second Update	18/05/16	-		In the second update SLB address the PPA's comments regarding their main area of interest around 80 Mile Beach and that should be no impact to brood shell stock. SLB have assessed the potential risk to brood shell stock at 80 Mile Beach and advised that due to the distance of the Operational Area over 300 km from 80 Mile Beach that the seismic activity will have no impact on pearl brood stock or pearling leases in that area. SLB commits to ongoing consultation with this stakeholder as per Section 3.4 and control measures described within Table 20 and Table 30.
Tourism and Recreation – Fishing and Boating					
Blue Horizon Charters	Telephone	19/11/15	-	Blue Horizon Charters does fish in the area, but cannot be specific with location or timing this far in advance. Requested a map and agreed to receive ongoing notification prior to activity commencement.	Consultation pack provided (06/11/15).
	First Update	24/02/16	08/03/16	Telephone: outlined zone of interest around Muiron Islands to Peak Island, agree to receive ongoing consultation by email and phone.	SLB commits to ongoing consultation with this stakeholder.
	Second Update	18/05/16	-	-	SLB commits to ongoing consultation with this stakeholder as per Section 3.4 and control measures described within Table 20.
Exmouth Fly Fishing	First Update	24/02/16	02/03/16	Telephone –confirmed operations occur within the Ningaloo MP, usually within the Gulf or to the shoreline West of the Gulf. Fishing activities are not conducted far offshore however they operate throughout the year. The Muiron Islands are sometimes visited.	SLB commits to ongoing consultation with this stakeholder.
	Second Update	18/05/16	-	-	SLB commits to ongoing consultation with this stakeholder as per Section 3.4 and control measures described within Table 20.
Exmouth Game Fishing	Consultation Pack	28/08/15	-	-	

Stakeholder	Engagement by SLB		Response from Stakeholder		SLB Merit Assessment and Action / Response
	Consultation Type	Date	Date	Stakeholder Response	
Club	First Update	24/02/16	03/02/16	Details provided of planned tournaments in the region for SLB to consider.	SLB has addressed the potential impact to planned tournaments in the EP.
	Second Update	18/05/16	-	-	SLB commits to ongoing consultation with this stakeholder as per Section 3.4 and control measures described within Table 20.
Tourism and Recreation – Ecotourism					
King's Ningaloo Reef Tours	Consultation Pack	26/11/15	-	No response	-
	First Update	24/02/16	-	No response	SLB followed up via telephone (26/02/16) and left a message with no response
	Second Update	18/05/16	-	Stakeholder confirmed that diving was heavily focused in the reef areas south of Tantabiddi to Coral Bay. Stakeholder does not expect snorkel divers to hear seismic noise several km away from the vessel, given the high levels of natural ambient noise.	In the second update SLB addressed the following concerns raised by tourism operators engaged in in-water activities such as SCUBA diving and snorkelling or swimming with marine fauna: • potential impacts to whale shark in feeding and aggregation areas around the Muiron Islands • potential for divers to hear underwater noise generated by seismic survey • potential disruption to whale shark tour season • potential disruption to humpback whale tour/swim season during important two year initial trial period around the North West Cape and Muiron Islands, especially the during peak season. SLB provided an assessment of these potential impacts and the associated control measures that will be implemented to reduce potential impacts on in-water activities, which are described in Table 20. SLB commits to ongoing consultation with this stakeholder as per Section 3.4.
	Telephone Call	19/05/16	-		
Ningaloo Blue Charters	Consultation Pack	26/11/15	-	No response	-
	First Update	24/02/16	01/03/16	Telephone - Stakeholder described general activities outside of Zone 2, however trial humpback tours in 2016 could venture into the southern area of Muiron Islands.	SLB commits to continue to provide this stakeholder with consultation updates.
	Second Update	18/05/16	-	-	In the second update SLB addressed the following concerns raised by tourism operators engaged in in-water activities such as SCUBA diving and snorkelling or swimming with marine fauna: • potential impacts to whale shark in feeding and aggregation areas around the Muiron Islands • potential for divers to hear underwater noise generated by seismic survey • potential disruption to whale shark tour season • potential disruption to humpback whale tour/swim season during important two year initial trial period around the North West Cape and Muiron Islands, especially the during peak season. SLB provided an assessment of these potential impacts and the associated control measures that will be implemented to reduce potential impacts on in-water activities, which are described in Table 20. SLB commits to ongoing consultation with this stakeholder as per Section 3.4.
Ningaloo Dive & Ningaloo Snorkel	Consultation Pack	26/11/15	-	No response	-
	First Update	24/02/16	01/03/16	Telephone – Diving tours take place from April to October around the Muiron Islands, the most popular location is on the West side.	SLB commits to continue to provide this stakeholder with activity updates.
	Second Update	18/05/16	-	-	In the second update SLB addressed the following concerns raised by tourism operators engaged in in-water activities such as SCUBA diving and snorkelling or swimming with marine fauna: • potential impacts to whale shark in feeding and aggregation areas around the Muiron Islands • potential for divers to hear underwater noise generated by seismic survey • potential disruption to whale shark tour season • potential disruption to humpback whale tour/swim season during important two year initial trial period around the

Stakeholder	Engagement by SLB		Response from Stakeholder		SLB Merit Assessment and Action / Response
	Consultation Type	Date	Date	Stakeholder Response	
					North West Cape and Muiron Islands, especially the during peak season. SLB provided an assessment of these potential impacts and the associated control measures that will be implemented to reduce potential impacts on in-water activities, which are described in Table 20. SLB commits to ongoing consultation with this stakeholder as per Section 3.4.
Ningaloo Ecology Cruises	Consultation Pack	26/11/15		No response	-
	First Update	24/02/16	01/03/16	Telephone – Stakeholder described general activities occurring outside of Zone 2, however noted that the company is hoping to put a second boat on in the latter half of 2016, which may go to the Muiron Islands with tourists.	SLB commits to continue to provide this stakeholder with activity updates.
	Second Update	18/05/16	-	-	In the second update SLB addressed the following concerns raised by tourism operators engaged in in-water activities such as SCUBA diving and snorkelling or swimming with marine fauna: • potential impacts to whale shark in feeding and aggregation areas around the Muiron Islands • potential for divers to hear underwater noise generated by seismic survey • potential disruption to whale shark tour season • potential disruption to humpback whale tour/swim season during important two year initial trial period around the North West Cape and Muiron Islands, especially the during peak season. SLB provided an assessment of these potential impacts and the associated control measures that will be implemented to reduce potential impacts on in-water activities, which are described in Table 20. SLB commits to ongoing consultation with this stakeholder as per Section 3.4.
Ocean Eco Adventures	Telephone	18/11/15	-	Whale shark tours generally occur within the Ningaloo MP. Due to nature of the activity, operations can occur at different locations on different days.	SLB commits to continue to provide this stakeholder with activity updates.
	Consultation Pack	26/11/15	08/03/16	Confirmed activities occurred in the Muiron MMA. Stakeholder expressed concern around the proposed survey timings (concurrent to humpback whale swims in a trial season). Main issue with the noise impacts would be around the humpback whale swim license his business (and others in the region) is trialling for a two year period around the North West Cape and Muiron Islands. August to October is a crucial time for his business with this trial. Concerned noise impacts could cause whales to become disgruntled, and putting paying customers in the water with disgruntled whales would be a risk that could potentially impact the future of the humpback whale swims in the area.	SLB acknowledged and addressed these concerns within the second update sent out to tourism operators (refer to summary of update below and control measures in Table 20).
	Second Update	18/05/16	-	-	In the second update SLB addressed the following concerns raised by tourism operators engaged in in-water activities such as SCUBA diving and snorkelling or swimming with marine fauna: • potential impacts to whale shark in feeding and aggregation areas around the Muiron Islands • potential for divers to hear underwater noise generated by seismic survey • potential disruption to whale shark tour season • potential disruption to humpback whale tour/swim season during important two year initial trial period around the North West Cape and Muiron Islands, especially the during peak season. SLB provided an assessment of these potential impacts and the associated control measures that will be implemented to reduce potential impacts on in-water activities, which are described in Table 20. SLB commits to ongoing consultation with stakeholders as per Section 3.4.
Three Islands Whale Shark Dive	Telephone	18/11/15	-	Business owner confirmed the business is active in the area around the Muiron Islands however did not express concern with a seismic, vessel based survey as long as there was no interaction with the vessel.	SLB commits to continue to provide this stakeholder with activity updates.

Stakeholder	Engagement by SLB		Response from Stakeholder		SLB Merit Assessment and Action / Response
	Consultation Type	Date	Date	Stakeholder Response	
	First Update	24/02/16	07/03/16	Telephone - Stakeholder confirmed his business operations generally centre around the West side of the Muiron Islands and run whale shark tours until July and will be introducing humpback whale swims tours which will run further into October.	-
	Second Update	18/05/16	-	-	In the second update SLB addressed the following concerns raised by tourism operators engaged in in-water activities such as SCUBA diving and snorkelling or swimming with marine fauna: • potential impacts to whale shark in feeding and aggregation areas around the Muiron Islands • potential for divers to hear underwater noise generated by seismic survey • potential disruption to whale shark tour season • potential disruption to humpback whale tour/swim season during important two year initial trial period around the North West Cape and Muiron Islands, especially the during peak season. SLB provided an assessment of these potential impacts and the associated control measures that will be implemented to reduce potential impacts on in-water activities, which are described in Table 20. SLB commits to ongoing consultation with this stakeholder as per Section 3.4.

Table 16: Summary of Consultation with Petroleum Activity Stakeholders

Stakeholder	Interests in the Area	Consultation Outcome
AWE Ltd	Exploration Permits: WA-511-P & WA-497-P	No concerns
BHP Billiton Petroleum (Australia) Pty Ltd	Exploration Permits: WA-255-P; WA-335-P; WA-351-P; WA-475-P Production Licences: WA-10-L; WA-12-L; WA-32-L; WA-42-L; WA-43-L	No concerns Development of ConOps plans as required. Ongoing notifications and updates.
Chevron Australia Pty Ltd	Exploration Permits: WA-205-P; WA-253-P; WA-268-P; WA-367-P; WA-374-P; WA-383-P; WA-392-P; WA-444-P; Retention Leases: WA-14-R; WA-15-R; WA-19-R; WA-20-R; WA-21-R; WA-22-R; WA-23-R; WA-24-R; WA-42-R; WA-53-R; WA-60-R Production Licences: WA-36-L; WA-37-L; WA-38-L; WA-39-L; WA-40-L Access Authority: WA-81-AA WA-37-L AA Application Number E2A1C7	No concerns
CGG Services (Australia) Pty Ltd	None	No planned activities or active petroleum titles within close proximity of operational area
Finder Pty Ltd	Exploration Permit: WA-500-P Exploration Permit: WA-520-P	No concerns
Hess Exploration Australia Pty Ltd	Exploration Permits: WA-390-P; WA-474-P; WA-518-P; WA-519-P	No concerns
Hydra Energy (WA) Pty Ltd	Retention Lease: WA-41-R	No concerns
Kufpec (Perth) Pty Ltd	WA-72-AA	License expired, no plans to renew.
Murphy Australia Oil Pty Ltd	Exploration Permit: WA-476-P	No concerns
OMV	[Permit farmed out to Woodside]	No concerns
PGS Australia Pty Ltd	No SPA or AA found	No concerns
Quadrant Energy Pty Ltd	Retention Lease: WA-49-R; WA-59-R Exploration Permits: WA-155-P; WA-214-P; WA-290-P; WA-320-P; WA-486-P; Production Licence: WA-35-L; WA-45-L; WA-55-L WA-37-L, WA-450-P, WA-290-P, WA-49-R, WA-358-P	No concerns
Tap Oil Ltd	Exploration Permit: WA-516-P	No concerns

Stakeholder	Interests in the Area	Consultation Outcome
TGS – NOPEC Geophysical Company Pty Ltd	WA-31-SPA WA-79-AA WA-75-AA	No concerns. On-going consultation required should both parties have operations planned.
Woodside Energy Ltd	Retention Leases: WA-36-R Exploration Permits: WA-271-P; WA-358-P; WA-428-P; WA-430-P; WA-461-P; WA-463-P; WA-478-P; WA-483-P Production Licence: WA-28-L Access Authority: WA-82-AA WA-34-L, WA-350-P	No concerns

3.4 Ongoing consultation

Consultation with stakeholders will be ongoing throughout the period the MSS EP is valid. Relevant persons have been encouraged to provide comment to SLB at any time. In the event that an objection or claim is presented by a stakeholder either prior to or during the activity, SLB will assess the merit of the objection or claim provided by relevant person and, where deemed necessary, will implement additional control measures to ensure all impacts and risks continue to be reduced to ALARP and are Acceptable.

Where it is not practicable to contact all individuals who may be affected, SLB will continue to maintain contact with key representative groups, and will ensure notices to mariners and AusCoast warnings are promulgated prior to commencement of the activity. SLB will continue to consult with individual fisheries license holders as part of this ongoing consultation process.

In addition to direct consultation with stakeholders, SLB will provide notification to casual / visiting stakeholders (such as recreational and commercial fishing vessels which do not typically frequent the region) through targeted notifications and notices. Representatives of these stakeholders who have been identified as relevant persons and will continue to be notified.

SLB has developed an ongoing consultation strategy to achieve the following key outcomes:

- Continue to identify relevant persons that may be affected by the activity and provide them with sufficient information; and
- Continue to identity and resolve any relevant stakeholder issues that may arise.

SLB will continue to identify relevant persons through the following:

- Six weeks prior to commencement, SLB will undertake a desktop review of potential new stakeholders in the region; including review of changes to petroleum titles, relevant EP submissions and new accepted EPs.
- Within two months from the commencement of the MSS, SLB will contact the Exmouth Visitor Centre, DPaW and DoF and enquire if they are aware of any new relevant persons entering the region.
- Where a new stakeholder is identified, SLB will engage them as soon as practicable (but within 48 hours of becoming aware) to provide them with sufficient details such that the risks and impacts to this stakeholder are reduced to ALARP and acceptable levels.
- Scout vessels will maintain on water presence supporting the seismic vessel to identify persons within the operational area
- SLB will distribute activity notices at key locations to target transient recreational users to provide key contact details and details of zones of potential risk.

In the event that undershooting is required as part of the activity, SLB will host a Hazard Identification (HAZID) workshop with relevant petroleum operators. The outcomes of the HAZID will inform the concurrent operations (ConOps) plan and the Management Of Change (MOC) process as required. The documented HAZID workshop outcomes will include the relevant rationale/ justification for arriving at key decisions, conclusions and relevant agreed conditions with petroleum operators (if any).

Prior to the commencement of the activity, SLB will provide specific details in relation to project timing and location to all relevant stakeholders again. This detail will further allow stakeholders an opportunity to determine if the activity may result in any issues.

3.4.1 Activity notifications to stakeholders

Prior to the commencement of the activity, SLB will provide specific details in relation to project timing and location to all relevant stakeholders. This detail will further allow stakeholders to determine if the location and the timing of the activity may result in any issues. As and where specifically requested, SLB will also provide stakeholder tailored pre-activity notifications; for example, so that navigational warnings and notices to mariners can be promulgated in a timely manner.

Pre-activity notifications are summarised in Table 17 below. Post-activity notifications are described in Table 18.

Table 17: Pre-activity notifications

Timing – prior to activity commencing	Stakeholder	Information Provided
4 weeks (28 days)	Shire of Exmouth Council (receptionist); and upload notice to www.exmouthinfo.com.au.	Activity notice: • Summary activity description and vessel and gear detail (i.e. size and avoidance zones etc.) • Activity co-ordinates • Date of activity commencement • Duration of activity • Describes key areas and times (relative to proximity of the vessel) recreational divers and fishers should look to avoid • Contact details for ongoing consultation
4 weeks (28 days)	All relevant stakeholders	• Summary activity description and vessel and gear detail (i.e. size and avoidance zones etc.) • Activity co-ordinates • Date of activity commencement • Duration of activity • SLB consultation contact details All dive operators and other marine based tourism operators will receive: • Planned start date and duration • Operational area map • names and contact details for all the SLB vessels (radio channels and telephones) • Key adopted DMAC diving controls • SLB shore-side contact information • Reminder to display required diver below signal on the vessel (Shapes / Flags / Lights).
4 weeks (28 days)	DMP	• Pre-start notification • Activity co-ordinates • Date of activity commencement • Duration of activity • SLB consultation contact details
4 weeks (28 days).	AHS	• Activity co-ordinates • Date of activity commencement • Duration of activity • Summary activity description and vessel and gear detail (i.e. size and avoidance zones etc.) • SLB consultation contact details • Vessel particulars including contact details
3 weeks (21 days).	Department of Defence - Joint Airspace Control Cell (JACC)	NOTAM (Notice To Airmen) application for all helicopter activities (details as required on formal NOTAM form). This will be provided by the designated contractor.
Up to 2 days prior	AMSA's Joint Rescue Coordination Centre (JRCC)	• Vessels details (including vessel name, call sign and Maritime Mobile Service Identity (MMSI)) • Satellite communications details (including INMARSAT-C and satellite telephone) • Activity co-ordinates (area of operation) • Date when operations start and end • Duration of activity • Summary activity description and vessel and gear detail (i.e. size and avoidance zones etc.) • SLB consultation contact details
10 days prior	NOPSEMA	• A written notification of the date of intention to commence an activity included within the EP.

Table 18: Post-activity notifications

Timing – prior to activity commencing	Stakeholder	Information Provided
Up to 1 week post (7 days)	DMP	Notification of activity cessation.
Relevant time post activity	AMSA	Summary of any significant or noteworthy interaction with commercial shipping during the survey.
10 days post completion	NOPSEMA	Notification to the Regulator in writing within 10 days following completion of the activity.

4 Impacts and Risks Assessment

4.1 Methodology

Regulations 13(5) and 13(6) of the OPGGS(E) Regulations require SLB to identify, analyse and evaluate the risks and potential environmental impacts associated with the Exmouth SLB15 MC3D MSS.

The risk management methodology is based on the principles, framework and processes defined by the Australian/New Zealand Standard AS/NZS International Standards Organization (ISO) 31000:2009 Risk Management – Principles and Guidelines (Figure 3). These are broadly consistent with SLB's internal risk assessment standard. The risk management processes included identifying risks and evaluating potential impacts associated with the activity, developing risk treatment (control) measures that will be adopted to reduce the risks to As Low As Reasonably Practical (ALARP), and assessing residual risks against criteria for risk Acceptance.

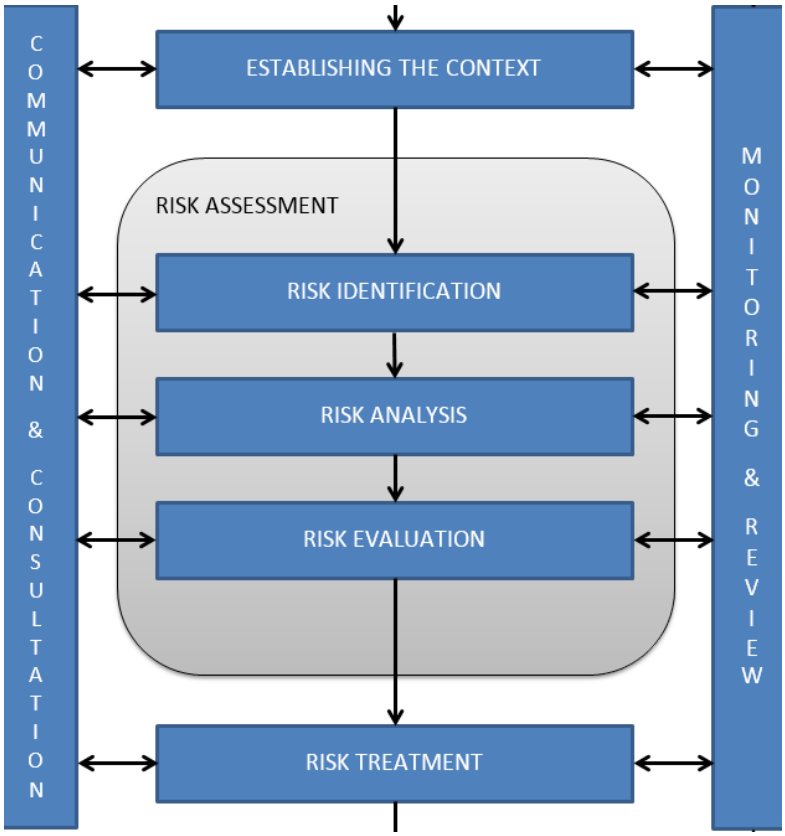


Figure 3: SLB EP Risk Management Process

4.2 EIRA summary

A summary of the worst case residual risk ratings for routine operations and non-routine activities and events are provided in Table 19.

Table 19: Summary of EIRA results for residual risks rating

EP Section	Highest Likelihood	Highest Consequence	Residual Risk
Routine Operations			
4.3 Interaction with other marine users	*UNLIKELY*	*MODERATE*	*MEDIUM*
4.4 Underwater Noise Emissions from Operation of the Acoustic Source	*UNLIKELY*	*MODERATE*	*MEDIUM*
4.5 Routine Permissible Waste Discharges	*UNLIKELY*	*SLIGHT*	*LOW*
4.6 Introduction and Establishment of Invasive Marine Species	*HIGHLY UNLIKELY*	*MAJOR*	*MEDIUM*
4.7 Artificial Light Generation	*UNLIKELY*	*SLIGHT*	*LOW*
4.8 Atmospheric Emissions	*REMOTE*	*SLIGHT*	*LOW*
Non-Routine Activities and Events			
4.9 Physical Presence: Collision or Entanglement with Marine Fauna	*REMOTE*	*MODERATE*	*LOW*
4.10 Seabed Disturbance: Loss of Equipment	*UNLIKELY*	*SLIGHT*	*LOW*
4.11 Loss of Hazardous and Non-hazardous Substances	*HIGHLY UNLIKELY*	*SLIGHT*	*LOW*
4.12 Hydrocarbon spill	*HIGHLY UNLIKELY*	*MINOR*	*LOW*
4.13 Response to a hydrocarbon spill	*UNLIKELY*	*SLIGHT*	*LOW*

4.3 Interaction with Other Marine Users

4.3.1 Description of Source of Impact

Other marine users such as commercial and recreational fishing vessel operators, commercial shipping companies and oil and gas facility operators may be temporarily displaced by the presence of the survey vessel and the streamers extending 8 km behind the vessel. The seismic vessel will have restricted ability to manoeuvre during acquisition due to the towed seismic spread (8 km long streamers over a horizontal area of 1.1 km, therefore 8.8 km^2 area). Other vessels will need to deviate their courses to avoid the seismic vessel. Undershooting may occur around offshore petroleum infrastructure, which may limit other petroleum activities during this time. In addition, underwater noise from the seismic vessel may directly interfere with diving operations in close proximity to the source or indirectly affect the catchability of fish if they are avoiding the noise. There is also potential for the seismic noise to affect the behaviour of marine megafauna which could in turn affect the tourism operators' ability to run marine megafauna charters as effectively. Bearing in mind that most of the time the seismic vessel will be in deep offshore waters rarely used by other users, the potential for interference is limited.

4.3.2 Known and Potential Impacts to Other Marine Users

The known and potential risks and impacts to other marine users are:

- temporary and intermittent displacement from the Operational Area
- risk of fishing gear, particularly fish traps and long lines, snagging on the seismic streamers
- risk of interference with diving operations and underwater noise disturbance to divers

- reduced catchability of fish (addressed in Section 4.4.2.7 and Section 4.4.2.15)
- lower numbers of marine megafauna available for 'whale-watching' tours.

In addition there is also the risk of non-routine events occurring:

- risk of navigational hazards e.g. from lost equipment (addressed in Section 4.10)
- risk of vessel collision (addressed in Section 4.9).

4.3.2.1 Potential Impacts to Petroleum Activities

There is a potential risk of interference with other petroleum activities carried out under active petroleum instruments within or overlapping the Operational Area.

A complete list of petroleum operators with petroleum instruments within/overlapping the Operational Area and planned activities is described in Table 14. To date, consultation with petroleum operators has not presented any issues associated with the proposed activities. All operators have indicated that the Access Authority (AA) process provides a suitable mechanism for resolving any issues.

Seismic operators have been contacted to understand any potential overlap in planned activities within the wider regional area. Seismic operators to date have also indicated that the planned activity does not represent a significant risk to their activities and that currently no concurrent activities are planned. Ongoing consultation and the AA process are identified as being required to continue to identify and resolve issues if these arise.

In addition to other vessel traffic and offshore support activities, there is a potential of encountering fixed structures within the Operational Area. This may include a number of drilling rigs, fixed platforms, floating production storage and offloading (FPSO) facilities, pipelay or construction vessels, and associated support activities. Undershooting may be necessary to gain data under existing facilities which will require an additional vessel to operate as a seismic source vessel and likely pass on both sides of the infrastructure; however both the seismic and source vessel will comply with any relevant petroleum safety zones (PSZs) and will not pass within 500 m of the infrastructure/facility. Entry into an exclusion zone may be requested by an operator to collect data over a specific area.

Incidents involving collision with infrastructure have the potential to escalate and significantly impact the operator and titleholder interest, especially if shut-down and lost production occurs. However, such an incident is not considered to be credible with heightened controls in these areas. This issue is also addressed through the AA process and in ongoing consultation with petroleum operators.

The stakeholder consultation process has allowed SLB to gain a greater understanding of other petroleum activities planned in the Operational Area. Given the absence of concerns raised during the AA process, it is unlikely that a negative interaction between the seismic/supply vessels with petroleum interests will occur. In the event that undershooting is required, e.g. if data indicates a requirement within exclusion zones around existing infrastructure / facilities, then SLB will hold a Hazard Identification (HAZID) workshop with the relevant petroleum stakeholder to inform preparation of a concurrent operations (ConOps) plan.

The presence of the survey vessel and towed array in the Operational Area has the potential to present a navigational hazard to other vessels; however, ongoing consultation and notification of the location and exact timing prior to the survey and vessel position and activities during the survey will be implemented to manage any potential impacts or risks.

4.3.2.2 Potential Impacts to Commercial Fishing

A number of fisheries stakeholders have indicated the potential for concurrent activities in the region (Section 3.3), therefore control measures have been develop where practicable to addresses potential interference with fishers' activities. The seismic vessel will have restricted ability to manoeuvre, but will only be present for short periods in any given area. Currently, no direct timing conflict has been described. SLB will continue to work with fishers to plan operations so that the actual risks of interference are reduced to ALARP and are acceptable.

Through stakeholder consultation processes, Fat Marine advised Schlumberger of concerns around catchability of fish and that fish it believed fish could be affected up to 10 miles (~20 km) from a seismic source. However, modelling has shown

that the relatively small airgun volume to be used in the Exmouth SLB15 MC3D MSS will only affect fish behaviour over a horizontal distance of approximately 600 m to 2.6 km from the active seismic source. Any effects on catchability will be temporary in any location as the seismic vessel traverses along each survey line. Further, the seismic vessel will not operate in shallow water or directly over shallow reefs where site-attached fish species occur, as the shallowest water depth that the vessel will operate is 30 m (which makes up a very small proportion of the operational area), with the majority of data acquisition in >200 m water depth. Refer to Section 4.4 for a detailed assessment of noise impacts on fish and on fish catchability.

The Pearl Producers Authority (PPA) has advised SLB of the following:

- PPA's main area of interest is in the vicinity of 80 Mile Beach.
- There are no active pearling leases in the Operational Area.
- PPA does not have any real concerns as long as the activity does not impact brood shell stock.

The Operational Area is over 300 km from 80 Mile Beach and the seismic activity will have no measurable impact on pearl brood stock or pearling leases in this area. PPA also advised that its concerns were limited to waters less than 100 m deep, of which there is a very small area in the south-eastern corner of the operational area. The potential for impacts on the pearling industry is considered very low.

Where possible, it is the intent to plan operations to avoid other stakeholder's planned activities (including adopting buffers around known activities). Schlumberger has developed controls for advising its daily Operational Areas to allow other users, including Fat Marine and other fishers, to avoid fishing in areas potentially affected by the seismic noise (see Table 15).

4.3.2.3 Potential Impacts to Commercial Shipping

AMSA has established a network of Shipping Fairways off the north-west coast designed for keeping shipping traffic away from offshore infrastructure and to reduce the risk of collision. Use of the fairways is strongly recommended but not mandatory and use of these fairways does not give vessels any special right of way (AMSA 2012). The operational area intersects two shipping fairways that run in a generally north south direction, parallel to the coast and outside the 1,000 m depth contour. Shipping density reports from February 2016 show a path from Exmouth to offshore petroleum facilities west of Barrow Island, coastal traffic and vessel movements across the operational area. Given this, it is likely that commercial shipping activities will be encountered during the MSS, especially within areas nominated as fairways and near areas with petroleum infrastructure and other operator interests (i.e. drill sites).

AMSA RCC and AHS require pre-activity notifications provided to allow sufficient levels of warnings/notices to be issued prior to the activity. The presence of the survey vessel and towed array in the Operational Area has the potential to present a navigational hazard to other vessels; however, ongoing consultation and notification of the location and exact timing prior to the survey and vessel position and activities during the survey will be implemented to manage any potential impacts or risks.

The Australian Transport Safety Bureau's marine safety database (http://www.atsb.gov.au/publications/safety-investigation-reports.aspx?Mode=Marine), has no records of collisions, groundings or sinking of seismic survey vessels or support vessels in Australian waters in at least the last 30 years.

However based on the limited manoeuvrability of the seismic survey vessel and scale of seismic equipment described, it is reasonable to conclude that the uncontrolled activity could present as a credible hazard to navigation and there remains a potential risk of vessel or equipment collision or incident. As such, controls measures are required to reduce this risk to ALARP and an Acceptable level.

4.3.2.4 Potential Impacts to Defence Activities

The Department of Defence (DoD) may undertake Air Force training exercises over the Operational Area. Activities are coordinated from the RAAF Learmonth Base through the provision of pre-activity notifications (Section 3). The DoD has no objection to the planned Exmouth SLB15 MC3D MSS (Section 3), but has requested notification to the JACC prior to any helicopter use and operational activities. The DoD also requested that a notification be provided to the AHS once the survey details (timing, location) are known. The DoD confirmed their intent to provide ongoing advice if any planned operations present an issue to their activities.

4.3.2.5 Potential Impacts to Tourism and Recreation (Non-diving)

This group of receptors includes stakeholders with recreational and tourism interests in the Operational Area. Recreational interests include recreational fishing and boating, ecotourism (e.g. whale shark swim operators) and recreational divers – refer to Section 3 for a list of stakeholders identified as relevant persons for the Exmouth SLB15 MC3D MSS. Recreational divers are described in the next section.

While activities such as tourism, recreational fishing and non-commercial shipping traffic are generally concentrated within State waters and within the vicinity of the population centres such as Exmouth and Onslow, such activities cannot be discounted from occurring within the Operational Area, or within the area ensonified during the survey. Therefore SLB has consulted with relevant persons and will continue to provide activity updates and pre-activity notifications as part of the ongoing consultation process.

Ecotourism businesses operating reef tours, whale shark and humpback whale trips have activities planned in 2016 and very likely in 2017 and 2018. If these occur within close proximity to the seismic vessel, there is a risk of indirect impacts associated with the potential disturbance of humpback whales or whale sharks (that these operators follow). The assessment within this sub-section focuses on potential impacts to tourism and recreational users carrying out non-diving activities; for further details of assessments of diving and indirectly to marine fauna refer to:

- Section 4.3.2.6 for the assessment of interactions with diving and swim activities
- Section 4.4.2.11 for the assessment of the potential risks to whale sharks
- Section 4.4.2.8 for the assessment of the potential risks to humpback whales.

As described in Section 2, recreational fishing activities occur throughout the region and the waters of the Ningaloo MP support various game fishing tournaments through the year. Known fishing tournaments planned during 2016 include: GAMEX (11 – 19 March); Masters Billfish Tournament (20 – 22 May); Ultra Light Game Fishing Tournament (29 – 21 August); Billfish Bonanza (22 – 13 November); and Heavy Tackle Billfish Tournament (15 – 18 December).

Ecotourism activities include whale watching, whale shark and manta ray observation, and whale/ whale-shark swimming, and 2016 marked the first year licenses have been made available for humpback whale watching and swimming tours for a trial two year basis. Ecotourism operators have been consulted through the consultation process during preparation of the EP and Schlumberger has been made aware of the following concerns (Section 3.3):

- Potential impacts to whale sharks in feeding and aggregation areas (see Section 4.4.2.11)
- Potential for divers to hear underwater noise generated by seismic survey (see Section 4.3.2.6 and Section 4.4.2.16)
- Potential disruption to whale shark tour season
- Potential disruption to humpback whale tour/swim season during important two year initial trial period around the North West Cape and Muiron Islands, especially the during peak season.

Whale shark tours have been identified by operators as occurring between March and September, although the peak period of aggregation around the Ningaloo MP west of North West Cape is between March and July (Section 3). Licenses for humpback whale watching and swimming tours will extend the current whale shark license period until October for all existing license holders, with stakeholders confirming that their humpback whale season is likely to run from July to October. Manta ray tours operate off Ningaloo between March and April.

Underwater noise modelling undertaken for the survey has predicted that whale sharks may avoid the seismic vessel at about 2.6 km from the seismic source; however the closest that the seismic vessel will ever be to the whale shark aggregation and foraging area running along the Ningaloo Coast is 8.7 km, so impacts to the tourism industry are unlikely. In addition, the whale shark foraging area further offshore and to the east of the Operational Area is geographically much less accessible to operators due to the large distance (and fuel costs) required to travel there and back on the usual one-day charters. Therefore no disturbance to whale shark tours is expected.

Avoidance behaviour was predicted by the noise modelling to be within 2.8 km of the seismic source for humpback whales, however the closest that the seismic vessel will operate to the humpback whale resting area in Exmouth Gulf is 14.5 km; and to the Muiron Islands 5.8 km. The seismic vessel could operate however during the humpback whale migration period,

however SLB have committed to a seasonal restriction to acquiring data within the 3 km zone north of the Ningaloo WHA in January or February only (see Section 4.4.2.8 and Figure 2 for the detailed assessment). The survey vessel will follow relevant cetacean interaction guidelines to minimise potential disturbance of important behaviours such as resting and migrating. Therefore no disturbance to humpback whale tours in this area is expected.

The ongoing consultation process established during preparation of the EP plays a vital role in understanding the activities and interests of relevant persons for the Exmouth SLB15 MC3D MSS and how the activities associated with the survey will affect those interests. Schlumberger has committed to contacting Exmouth-based tourism operators identified as conducting in-water activities 48 hours prior to the commencement of the survey to provide details of the survey lines to be acquired (in the form of a map). Local operators will be invited to confirm vessel location daily if desired (see Table 20). It is important to note that the vessel will only be at the eastern, inshore part of the sail lines for limited periods.

In addition to this ongoing process, SLB is aware of the need to target local community centres of activity and have placed an activity notification on the Exmouth Community notice board for the Shire of Exmouth Council prior to the submission of this EP (see Section 3.3). SLB also commit to providing an activity notice on the Exmouth Community notice board four weeks prior to the commencement of the activity. Standard required public notifications, including Notices to Mariners and AusCoast Warnings will be issued during the pre-notification period (see Table 20). Consequently impacts to tourism interests are expected to be minimal.

4.3.2.6 Potential Impacts to Divers (Tourism and Fishers)

Recreational divers associated with the ecotourism industry and commercial divers involved in the marine aquarium and shell specimen fisheries may hear the seismic noise if diving within a few km of the survey vessel. The lowest audible sound level for a human diver with normal hearing is around 67 dB re 1 Pa, with greatest sensitivity occurring at frequencies around 1 kHz (Fothergill et al. 2001). The type of breathing apparatus worn by a diver, i.e. diving helmet (dry ear) or hood (wet ear), is important in determining the noise hazard as human hearing is more sensitive in air than in water (Parvin et al. 1994). This is due to the 'wet' ear effect (water in contact with the head and in the auditory canal, such as SCUBA divers and band-mask divers) versus 'dry' ear effect (wearing diving helmets and the ear is surrounded by air) (Parvin et al. 1994). Studies have shown that there is a reduction in hearing sensitivity underwater for SCUBA divers, with commercial divers wearing helmets considered the 'worst' case group in terms of sensitivity to underwater noise (Parvin et al. 1994; Anthony et. 2010).

Schlumberger recognises the importance of the area for recreational diving and swimming activities and the concerns raised by ecotourism operators in this regard. Commercial diving fishers have not expressed concerns. Schlumberger has used underwater noise modelling to show that are likely to hear underwater noise from the seismic survey at distances of up 6 - 8 km from the source (Section 4.4.2.16). The details of the noise modelling and impact assessment are included in Section 4.4.2.16. It is conservatively predicted that divers further than 8 km from the seismic source will not be adversely affected by underwater noise from the seismic survey.

As a further precautionary measure due to the limited data surrounding effects of noise on recreational diver comfort and enjoyment of the tourism experience, a further 2 km safety buffer is proposed around the active seismic source (i.e. 10 km). Dive charter operators have been advised to avoid diving within the transient 10 km buffer zone around the source. Dive sites on the west side of the Muiron Islands (the known dive sites closest to the operational area) are over 5.5 km from the seismic source. It is likely that divers at this site would hear the seismic noise during the time when the vessel is within 8 km of the islands. This will be a temporary interference and dive operators will be advised 48 hours in advance to allow them to plan to visit alternative dive sites, if they want to avoid hearing the seismic noise. Given the vessel will only be present within 10 km of the islands when acquiring the eastern end of the sail lines and sometimes this will be at night and during periods of weather unsuitable for diving at sites exposed to westerly winds (afternoons in summer), potential for interference with divers is low.

4.3.2.7 Potential Cumulative Impacts

As the scheduling for Exmouth SLB15 MC3D MSS is not yet finalised, it is not yet possible to determine which other seismic surveys will be in progress during the activity. However, SLB is aware that other EPs for similar areas are in preparation and cumulative impacts are possible. Following acceptance of this EP and as part of the pre-survey planning and notification process, the NOPSEMA website will be monitored for accepted EPs for marine seismic surveys which could contribute to

cumulative noise in the Operational Area. If a survey is planned (accepted or submitted EP) within 40 km of the Operational Area, and scheduling for both surveys may overlap, the relevant titleholder will be contacted and arrangements made to ensure that the risk of cumulative impacts will be reduced to ALARP. SLB will not acquire seismic data within 40 km of another actively acquiring seismic vessel, as this can degrade the quality of the data. If commercially acceptable, the survey schedule may be modified to avoid temporal overlap between the surveys.

All currently submitted and approved EPs for seismic surveys have been investigated on the NOPSEMA website and those relevant to the Operational Area have been assessed for potential overlap and cumulative noise impacts. However, given that SLB will implement a minimum 40 km separation distance that will be maintained between active vessels, there is negligible potential for cumulative impact. This separation distance will eliminate the risk of cumulative impacts to whales, because individuals would be able to avoid the area of high underwater sound levels from one vessel and remain outside the 3 km increased precaution observation zone around the other active source, as recommended under EPBC Policy Statement 2.1 (DEWHA 2008a).

4.3.3 Control Measures and Measurement of Environmental Performance

Table 20 provides the control measures that SLB will implement during the activity to manage any potential interactions with other marine users. All control measures from Revision 1 of the EP have been assessed, and where Schlumberger considers that the sacrifice (in terms of time, cost and/or effort) is not grossly disproportionate to the environmental benefit gained, then those controls have been adopted for the activity.

4.3.4 Residual Risk

With the implementation of the control measures described in Table 20 above, the likelihood of impacts to other marine users during the activity is reduced to unlikely and of a consequence of moderate (i.e. loss of fishing gear/ loss of fish catch/ vessel damage/ impact to other petroleum activities/ financial implications etc.), with a residual risk of Medium. In accordance with the definition of a low residual risk within SLB's risk assessment matrix, the risk is therefore considered 'Broadly Acceptable'.

Table 20: Controls Measures and Environmental Performance Outcomes and Standards for Interactions with Other Marine Users

EPO: Avoid unplanned interference with third-party vessel and other concurrent activities.			
Control Measure	**EPS**	**MC**	**Responsible**
Compliance with the *International Convention of Standards of Training, Certification and Watchkeeping for Seafarers (STCW95):* SLB will comply with flag and class standards for watchkeeping and radio use to ensure that the infield actions and warnings can be readily implemented allowing timely notification for relevant persons to plan avoidance of the seismic survey vessel and equipment.	**EPS 1** The Vessel Master and bridge watch personnel are qualified to operate radio equipment (as required by STCW95).	Training and competency records indicate STCW95 competencies are met and up to date.	Vessel Master
	EPS 2 Qualified persons (as per EPS above) aboard all vessels will maintain 24 hour bridge watch to scout for other marine users.	Bridge log verifies 24 hour watch keeping.	Vessel Master
Compliance with *Marine Orders Part 30: Prevention of Collisions (Issue 8)* and *Part 21: Safety of navigation and emergency procedures (Issue 8)* specifically, use of standard maritime safety procedures (including radio contact, display of navigational beacons and lights).	**EPS 3:** The seismic survey vessel is equipped with two automatic radar plotting aids (ARPA), and Automatic Identification System (AIS).	Inspection report/record verifies vessels hold current survey certification for the Class type (i.e. confirms the required anti-collision monitoring equipment is in place), and that equipment is onboard, tested and operational.	Vessel Master
	EPS 4: Prior to the commencement of the survey, the anti-collision monitoring equipment (ARPA and AIS) are inspected and tested and confirmed as operational.		
	EPS 5: As required by vessel class, the seismic vessel will display day shapes, lights and reflective tail buoys to indicate the vessel is towing streamers and is therefore restricted in ability to manoeuvre.		
SLB will advise diving operators (tourism and fishing) of the dynamic 10 km diving exclusion zone around the seismic vessel and seek to resolve any conflicts in area use raised by consultees.	**EPS 6:** At least 48 hours prior to survey SLB or the seismic Vessel Master will contact fisheries/fishers actively involved in diving in the area and tourism operators identified as conducting in-water activities to provide details of the survey lines to be acquired (in the form of a map) to allow other users to raise potential conflict issues, or choose to avoid in-water activities within 10 km of the seismic vessel whilst the acoustic source is in operation. Fishers and tourism will be invited to confirm vessel location daily by radio if desired for more responsive planning.	Records of consultation (including maps) with fisheries/fishers actively involved in diving in the area and tourism operators identified as conducting in-water activities. Records of SLB responses to issues raised by stakeholders and solutions found.	SLB Project Manager or Vessel Master
	EPS 7: Where the seismic vessel is required to deviate from the “48 hour forecast” planned data acquisition area (e.g. in order to avoid marine fauna), the seismic Vessel Master or SLB will immediately communicate this to fisheries/fishers actively involved in diving in the	Bridge log / consultation records and warnings issued.	SLB Project Manager or Vessel Master

EPO: Avoid unplanned interference with third-party vessel and other concurrent activities.			
Control Measure	**EPS**	**MC**	**Responsible**
	area and tourism operators identified as conducting in-water activities'.		
SLB will manage interactions with other marine users through the use of a dedicated chase vessel.	**EPS 8:** Two support vessels (i.e. supply or chase vessels) will be used to support the seismic survey vessel with a minimum of one support vessel maintained at all times.	Bridge records onboard the seismic vessel confirms at least one vessel supporting at all times.	Vessel Master
	EPS 9: Support vessels will intercept other vessels in the area that do not actively avoid the seismic survey vessel or are at risk of entering the path/ avoidance zone of the seismic vessel and equipment.	Incident record logged when errant vessels require interception by support vessels.	Vessel Master
Streamer positioning controlled via use of the birds.	**EPS 10**: SLB will use birds on each streamer to control depth and horizontal positioning of the multicomponent cables.	Inventory records show birds are fitted to streamers.	Vessel Party Chief
Avoid overlapping concurrent seismic operations.	**EPS 11:** SLB will not approach closer than 40 km to other seismic activities.	Either the plotted survey course/ or radio communications/ or other means demonstrates the vessel complies with applicable avoidance distance.	Vessel Master
SLB would avoid entering exclusion zones around facilities. However, if data indicates that undershooting is required within exclusion zones around existing petroleum infrastructure / facilities, SLB will hold a Hazard Identification (HAZID) workshop to inform preparation of a concurrent operations (ConOps) plan.	**EPS 12:** If data indicates that undershooting is required within exclusion zones around existing petroleum infrastructure / facilities, SLB will host a Hazard Identification (HAZID) workshop with the relevant operator, the outcomes of which will be used to develop a ConOps plan.	Records of consultation undertaken. Record of HAZID workshop (including attendance and outcomes).	SLB Project Manager Vessel Master
	EPS 13: SLB will advise the Vessel Master of all applicable exclusion zones (including around existing petroleum infrastructure / facilities); details will include timeframe, coordinates, and contact details.	Inspection/audit verifies that Vessel Master has all planned exclusion zone details.	SLB Project Manager
Consultation with AMSA to ensure that warnings are issued to mariners in a timely manner; and post survey consultation with AMSA ensures that the Industry is aware of lessons learnt based on experiences during the actual activity.	**EPS 14:** At least two days prior to the commencement of the activity, SLB will provide AMSA's Rescue Coordination Centre (RCC) with all required survey details (vessel, equipment, avoidance zones, location, timing and duration etc.) so that AusCoast warnings can be issued and kept up to date.	Consultation records and warnings issued.	Vessel Master
	EPS 15: AMSA Joint RCC will be notified of survey completion (notification provided with appropriate timing prior to completion so that AusCoast Warnings can reflect the end of survey date) as requested through consultation.	Consultation records and warnings issued.	SLB Project Manager

EPO: Avoid unplanned interference with third-party vessel and other concurrent activities.			
Control Measure	**EPS**	**MC**	**Responsible**
	EPS 16: SLB will provide AMSA with end of activity summary of any significant or noteworthy interaction with commercial shipping during survey.	Records of consultation undertaken.	SLB Project Manager
Notices to mariners are issued detailing planned survey vessel operations.	**EPS 17:** At least 4 weeks (28 days) prior to the commencement of the activity, SLB will provide AHS with survey details (seismic survey vessel, avoidance zones location, timing, duration etc.) to enable AHS to issue a Notice To Mariners.	Consultation records and Notice To Mariners.	Vessel Master
Consultation with Department of Defence to ensure that the activities is effectively managed to coincide with other potential Department of Defence activities.	**EPS 18:** At least 3 weeks (21 days) prior to the commencement of the activity, SLB will notify the Department of Defence of the planned activities (details to be provided will be sufficient to meet the requirements of the Notice To Airmen (NOTAMs) documentation and any other requirements of the Department of Defence.	Consultation records indicate the Department of Defence receipt and acknowledgment of the activity details.	SLB Project Manager
Consultation with the Department of Mines and Petroleum through provision of a pre-activity notification.	**EPS 19:** At least 4 weeks (28 days) prior to the commencement of the activity, SLB will provide DMP with a pre-start notification, activity co-ordinates, date of activity commencement, duration of activity and SLB consultation contact details.	Consultation records indicate the Department of Defence receipt and acknowledgment of the activity details.	SLB Project Manager
Ongoing consultation with relevant stakeholder will ensure that stakeholders have sufficient information to make an informed decision of the risks and re-assess impacts that the activity may present for their interest.	**EPS 20:** At least 4 weeks (28 days) prior to the commencement of the activity, SLB will notify relevant persons with key details of the MSS acquisition timing, location, duration and potential risks and impacts relative to the proximity the source vessel and planned location.	Consultation records show pre-activity notifications provided to relevant persons listed in Section 3).	SLB Project Manager
Activity notice will be provided at a strategic location to ensure that recreational users have an additional avenue for activity awareness (in addition to navigational warnings and AusCoast warnings).	**EPS 21**: At least 4 weeks (28days) prior to the commencement of the activity, SLB will provide the Shire of Exmouth receptionist (via email) an activity notice for public display on the large Shire Community Notice Board; and will upload the notice on to www.exmouthinfo.com.au for display on the 'Exmouth info' website. This activity notice will describes key areas and times (relative to proximity of the vessel) that recreational divers and fishers should look to avoid.	Consultation records; and copy of activity notice distributed.	SLB Project Manager
SLB will call relevant persons to consult on the potential for overlap with the MSS to manage and conflict that may arise.	**EPS 22**: Within 7 days of providing the pre-activity notification, SLB will call relevant persons with confirmed and possible concurrent activities with the MSS (where phone numbers are available); and will leave a details phone message for those stakeholders who do not answer their phone.	Consultation records kept for phone conversations/ messages.	SLB Project Manager

EPO: Avoid unplanned interference with third-party vessel and other concurrent activities.			
Control Measure	**EPS**	**MC**	**Responsible**
Compliance with exclusion zones. Vessels will comply with all applicable Petroleum Safety Zone (PSZ) as nominated by petroleum operators associated with petroleum infrastructure.	**EPS 23:** SLB will not enter into a charted PSZ or within 500 m from offshore infrastructure/facilities without a current ConOps plan, approved by operator, in place.	Vessel tracking records demonstrate that PSZ are not entered unless ConOps in place.	Vessel Master
Ongoing identification and consultation with new stakeholders	**EPS 24:** Six weeks prior to commencement, SLB will undertake a desktop review of potential new stakeholders in the region; including review of changes to petroleum instruments, relevant EP submissions and new accepted EPs.	Project record (emails/ meeting record/ MOC or other documentation) demonstrating review findings. Records of consultation.	SLB Project Manager
	EPS 25: Within two months from the commencement of the MSS, SLB will contact the Exmouth Visitor Centre, DPaW and DoF and enquire if they are aware of any new relevant persons entering the region.		
	EPS 26: Where a new stakeholder is identified, SLB will engage them as soon as practicable (but within 48 hours of becoming aware) to provide them with sufficient details such that the risks and impacts to this stakeholder are reduced to ALARP and acceptable levels.		
Prohibit recreational fishing from the seismic and support vessels	**EPS 27:** Recreational fishing will be prohibited from the seismic and support vessels at all times.	Induction records show that all crew are aware of prohibition.	Vessel Master
Should any conflicts arise between SLB survey activities and fishers (commercial and charter) activities, SLB will take action to avoid or mitigate conflicts.	NEW EPS N9: SLB will continue to advise fishers of planned sail-lines and dates and if any issues are raised by fishing stakeholders, SLB will take action, including further controls, to avoid or minimise conflicts. Controls to be considered will include: ▪ Moving to another sail-line ▪ Deviating around fishing activity area by 3 km ▪ Allowing fishers to fish area prior to seismic acquisition ▪ Minimise survey activity in areas where there is known fishing activity.	Survey consultation records show merit assessment and consideration of controls in response to stakeholder feedback prior to and during survey.	SLB Project Manager
If potential for significant conflict exists with other users, SLB to implement adaptive management	NEW EPS N10: SLB will take reasonable steps to avoid or minimise conflict with other marine users, should such a conflict be identified during ongoing consultation with stakeholders.	Survey consultation records show merit assessment and consideration of controls in response to stakeholder feedback prior to and during survey.	SLB Project Manager

4.4 Underwater Noise Emissions from Operation of the Acoustic Source

4.4.1 Description of Source of Impact

The dominant source of underwater noise during the Exmouth SLB15 MC3D MSS will be from the operation of the seismic source (airgun array), which is proposed to be in frequent operation for the duration of the activity. However, there will be periods when the airguns are not in operation, e.g. during maintenance, refuelling and marine fauna shut-downs.

4.4.1.1 Seismic Source

The survey vessel will tow an array of airguns, which will be fired at regular intervals (shot point interval) producing pulses of high intensity (sound energy), low frequency noise. Seismic pulses typically have 98% of the signal power in dominant frequencies less than 200 Hz; predominantly in the 6 to 100 Hz range (McCauley 1994), which is the range most useful for seismic data imaging. The array comprises a carefully tuned series of airguns that are fired to generate a pulse of acoustic energy of sufficient power to penetrate the geological formations of interest. The volume of the airgun array is a useful indicator of sound energy (measured in dB); however, the configuration of individual arrays has a significant effect on the actual power output. Seismic airgun modelling packages (e.g. Gundalf and Nucleus) calculate a theoretical maximum energy level at 1 m from the source array for a specific configuration. Actual sound levels are significantly lower than the theoretical source maximum because the cumulative sound pressure levels (energy from all guns firing together) are computed on the assumption that the seismic array is a point source. However, the guns are further than 1 m apart in the array and it is not possible to be 1 m from all compressed air elements in a source array simultaneously. This is important in understanding that modelled gun power levels are inherently conservative and therefore, sound transmission loss modelling, (estimating the propagation of sound through the water), starts with an inflated source level.

Near-field (close to the source) and far-field received sound levels are influenced by a number of factors including the overall size (capacity) of the acoustic source, water depths in the area, distance from the source and geo-acoustic properties of the seabed.

4.4.1.2 Vessel Noise

The survey vessel and the support vessel(s) will generate low levels of machinery noise, especially when using propulsion thrusters. This vessel noise will be at a much lower level than that emitted from the active seismic source. While these sources are in operation, the underwater sound generated by vessels will be a negligible addition to the cumulative underwater sound levels.

There will be very limited periods of time when the seismic source or bathymetric equipment are not operational e.g. during maintenance, refuelling and marine fauna shut-downs, during which engine noise will be the major source. However, it is unlikely that engine noise levels will be greater than that of any other vessel normally operating in the Operational Area. Underwater noise from general vessel operations is not considered further in the impact assessment, because it is assumed that any potential for effect is far outweighed by the effects of the seismic source and there would be negligible cumulative effect.

4.4.1.3 Helicopter Noise

Helicopter engine noise is emitted at a range of frequencies, and generally of a low frequency below 500 Hz (Richardson et al. 1995). Sound pressure is greatest at the surface and rapidly diminishes with increasing depth. Underwater noise reduces with increasing helicopter altitude, but the duration of audibility often increases with increasing altitude.

Richardson et al. (1995) reported helicopter noise (for Bell 214 type) being audible in air for four minutes before it passed over receivers, but only detectable underwater for 38 seconds at 3 m depth and 11 seconds at 18 m depth for the same flight path. Helicopter noise is highly transient and is considered to pose limited risk of physiological/or significant behavioural effects to cetacean or turtles unless hovering over animals for an extended period of time (resulting in behavioural avoidance). Control measures described in Table 56 will ensure direct routes to activities primarily to avoid bird strikes particularly in key protected and significant areas.

Importantly, it is not reasonable to apply additional controls limiting take-off and landings from the heli-deck of the vessel (i.e. in event of cetacean or turtle presence), as this manoeuvre has priority for the protection and safety of crew and infrastructure.

4.4.2 Known and Potential Impacts to Environmental Receptors

The known and potential environmental impacts from routine operational discharges are:

- physical injury to auditory tissues or other air-filled organs at very close range
- hearing loss, temporary threshold shift (TTS) or permanent threshold shift (PTS)
- direct behavioural effects through disturbance or displacement and consequent disruption of natural behaviours or processes, e.g. migration, feeding, resting, calving
- indirect behavioural effects by impairing or masking the ability to navigate, communicate or find food (by affecting the distribution or abundance of prey species)
- indirect effects on the catchability of fish.

The potential for impact on individual animals depends on a number of factors, including the individual's proximity to the noise source, its ability to avoid the sound field generated by the airgun array, its specific physiological tolerance and the overlap between its hearing range and the seismic frequency range. Most of the sound energy of the seismic airgun pulses is in the low frequency range of 10 to 200 Hz (McCauley 1994; OGP 2011). This overlaps with the frequency range of some marine fauna groups, but is unlikely to be heard by many marine species. The marine species most at risk from acoustic disturbance from seismic operations within the operational area are cetaceans migrating through the area, particularly baleen whale species that hear and communicate in a similar low frequency range to the range of noises produced by seismic sources.

In general the risks and potential impacts are well understood with regard to potential mechanisms of mortality and/or physiological injury; however uncertainty lies in the critical thresholds for many taxa and in understanding the spatial and temporal extents of behavioural disturbances and the potential effects on populations. IN the light of such uncertainty highly precautionary approached have been taken.

Commercial fishing groups (Section 3.3) have specifically expressed concern regarding the potential for noise generate by the seismic source to affect the quality and quantity of stock, catch rates and larval recruitment. This EIRA discusses potential impacts to fish species, fish catch rates and larval stages (planktonic organisms).

The discharge of the high-energy acoustic source in the Operational Area has the potential to affect adversely the following environmental values and sensitivities, to varying degrees:

- plankton (including larvae of commercially important fish)
- fish and shellfish – pelagic and demersal species (including site-attached species as these species are less likely to be able to avoid the sound source at distance and are expected to seek shelter within the reef)
- whale sharks (migration and aggregation/foraging)
- manta rays (migration and aggregation)
- humpback whales (migration and biologically important area for resting in Exmouth Gulf)
- pygmy blue whales (migration and possible foraging area)
- transient cetacean species (e.g. Bryde's whale, Antarctic minke whale, sperm whale, killer whale)
- coastal dolphin species (spotted bottlenose dolphin, Indo-Pacific humpback dolphins)
- dugong (breeding and feeding areas in Exmouth Gulf)
- nesting and inter-nesting turtles (nesting on Ningaloo Coast and Muiron Islands)
- protected area values (Ningaloo WHA / CMR / MP, Muiron Islands MMA, Gascoyne CMR, KEFs).

4.4.2.1 Underwater Noise Modelling

SLB engaged SLR to undertake noise decay modelling for the proposed survey, in order to predict the received sound exposure levels (SEL) from the survey at increasing distances from the survey operations (SLR 2015). Modelling was conducted for the discharge of the 3,147 in^3 array (with a source sound pressure level of 258 dB re 1 μPa-m) at the south-eastern corner of the Operational Area; the point closest to the Exmouth Gulf humpback whale resting area and adjacent to the Ningaloo WHA MP and CMR and Muiron Island MMA. The modelling study included three key components:

- Array source modelling - modelling the sound energy emissions from the array source, including its directivity characteristics.
- Short range modelling - prediction of the received SEL over a range of a few kilometres from the array source location, in order to assess whether the proposed survey complies with the regulatory mitigation zone requirements.
- Long range modelling - prediction of the received SEL over a range of tens to hundreds of kilometres from the array source location, in order to assess the noise impact from the survey on more distant sensitive marine areas.

The results of short (Figure 4) and long range modelling show that the shallow water environment on the eastern side of the operational area significantly attenuates noise propagating from the source location towards the Muiron Islands (Figure 5). Due to the sound blockage by the Muiron Islands and Peak Island, received noise levels at locations inshore of the islands will be negligible (SLR 2015).

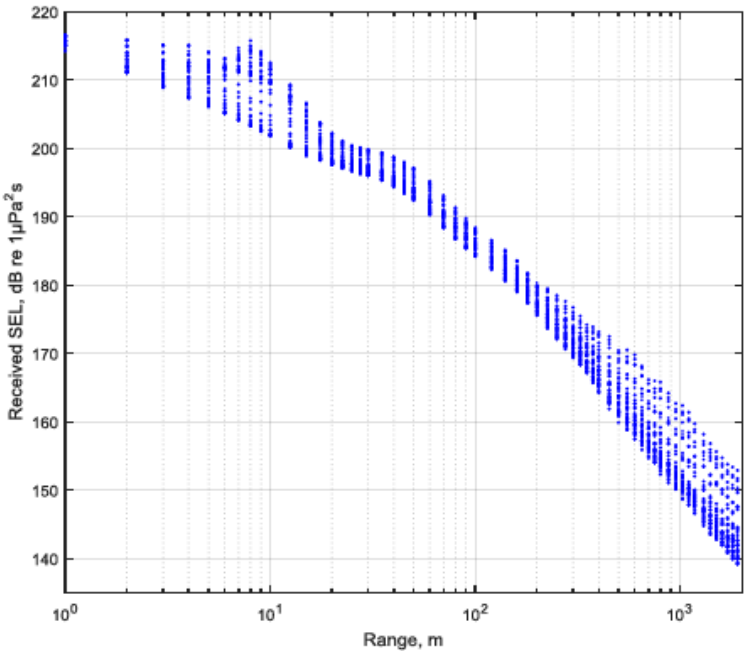


Figure 4: Short range modelling scatter plot of predicted maximum SEL across the water column from the 3,147 in^3 array for all azimuths as a function of range from the centre of the source array

The maximum received sound exposure levels (SELs) in any direction, at increasing distance from the source, are presented in Table 21. Modelling undertaken for the planned seismic source for the activity was reported in SEL dB values (dB re 1 $\mu Pa^2.s$), however in order to compare the results with thresholds reported in the literature it has been necessary to apply a conversion factor. McCauley et al. (2000) state that, while converting SEL values to SPL peak to peak values is technically not valid, it is often necessary so that received levels can be compared across studies. It is also necessary for comparison with widely accepted thresholds in different units. McCauley et al. (2000) calculated correction factors for many thousands of seismic source readings, for which the corrections were found to be consistent over many kilometres, and proposed a correction factor of +27.3 to +30.5 dB above the SEL value can be applied. This 'SEL to SPL' correction method was used for extrapolating the modelled SEL values to SPL (peak-peak). The upper level correction factor of +30.5 dB was used as a conservative measure to address potential uncertainty.

Figure 5 shows that, the received noise levels at long range vary significantly at different angles and distances from the source. This directionality of received levels is due to a combination of the directionality of the source array, and propagation effects caused by bathymetry and sound speed profile variations (SLR 2015).

Table 21: Predicted maximum received SELs for all azimuths from the 3,147 in^3 source

Sound Level Metric	Grey refers to the maximum modelled SEL at different ranges, dB re 1μPa^2·s							
	10 m	50 m	100 m	200 m	500 m	1.0 km	1.5 km	2 km
SEL dB re 1 μPa2·s	213.0	198.2	188.4	180.5	170.5	162.5	155.6	152.5
SPLpeak-peak dB re 1 μPa	243.5	228.7	218.9	211	201	193	186.1	183

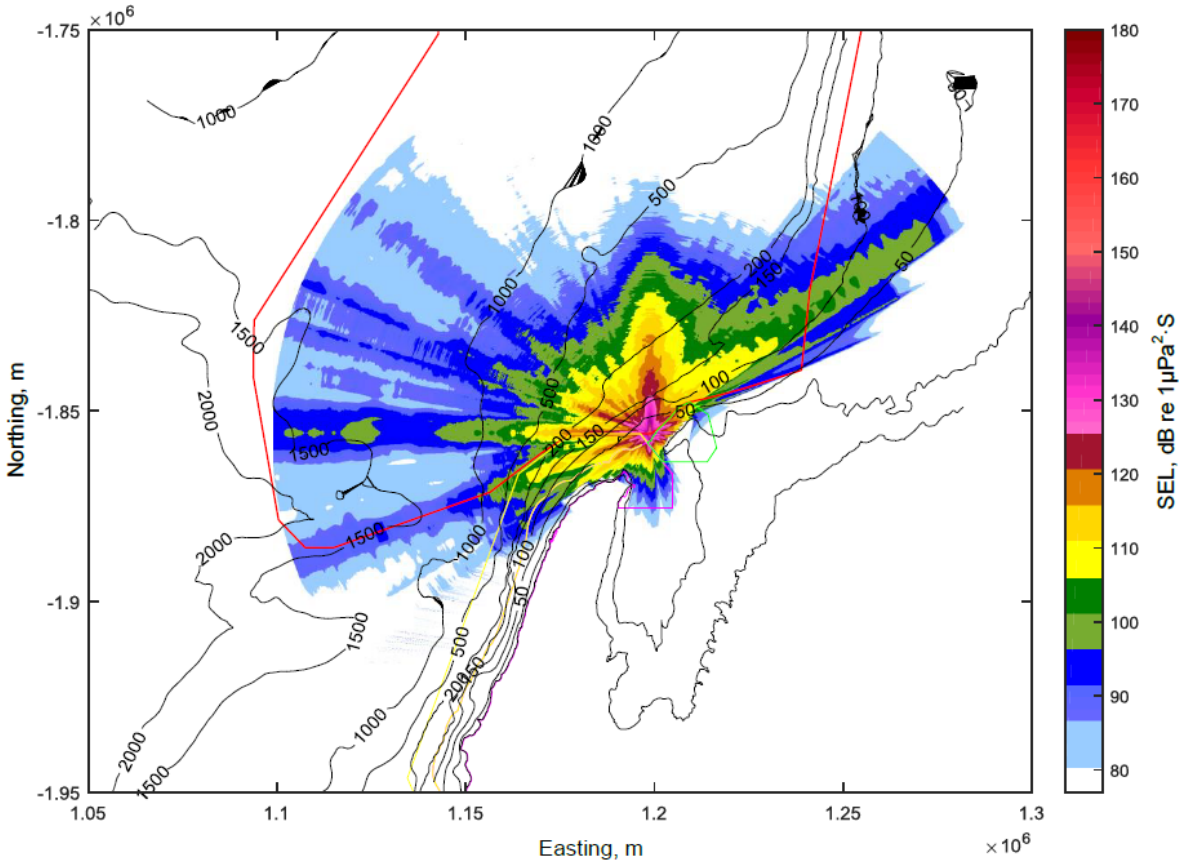


Figure 5: Long range modelling of maximum SEL across the water column from the 3,147 in^3 array

4.4.2.2 Marine Fauna Exposure Criteria Adopted for this Assessment

Noise exposure thresholds are indicative noise levels at which certain effects (e.g. mortality, temporary hearing impairment, behavioural responses) are predicted, and may be defined for single noise exposures or for cumulative exposure to successive events.

Fish

The thresholds for harm to fish species have been based on the sound exposure guidelines for fish proposed by the ANSI-Accredited Standards Committee S3/SC 1, Animal Bioacoustics Working Group, (Popper et al. 2014). The guidelines represent the Working Group's consensus efforts to establish broadly applicable guidelines for fish (and sea turtles), with specific criteria relating to mortality and potential mortal injury and recoverable injury (Table 22). The Working Group defines the criteria for injury as follows:

- mortality and mortal injury – immediate or delayed death.
- recoverable injury – injuries, including hair cell damage, minor internal or external haematoma, etc. None of these injuries is likely to result in mortality.

Table 22: Summary of Fish Injury Noise Exposure Guidelines for Seismic Airguns (Popper et al. 2014)

Type of Fish	Mortality and Potential Mortal Injury SPL (dB re1 μPa)	Impairment and Recoverable Injury SPL (dB re1 uPa)	Strong Behavioural Avoidance SPL (dB re1 uPa)
Fish: no swim bladder (particle motion detection)	>213	>213	173
Fish: swim bladder is not involved in hearing (particle motion detection)	>207	>207	173
Fish: swim bladder involved in hearing (primarily pressure detection)	>207	>207	173

The guideline levels for each of the criteria above have been derived from a number of sources. The mortality and recoverable injury guidelines are based on predictions derived from effects of impulsive sounds from piling (Halvorsen et al. 2011), since there are no quantified data for seismic airguns. Popper et al. (2014) acknowledge that there are few data regarding the effects of seismic airgun noise on fish mortality and damage to organ systems, and that studies of fish with swim bladders have not shown mortality to date (Popper et al. 2007; Hastings et al. 2008; and McCauley and Kent 2012). In the absence of such data, the guidelines for "mortality and potential mortality" and for "recoverable injury" have been extrapolated from piling studies and are therefore typically conservative and precautionary in nature (Halvorsen et al. 2011; and Popper et al. 2014). It is, however, important to note that the intent of authors in proposing these guidelines was as *"a first step in setting guidelines that may lead to the establishment of exposure standards for fish (and sea turtles)"* (Popper et al. 2014).

Both cumulative SEL and peak SPL guidelines have been proposed, however the Working Group states that the direct application of cumulative criteria adopted for piling driving to seismic airguns would not be appropriate. This is because the received peak SEL (or "single strike" SEL) changes from shot to shot since the seismic vessel is moving and will be at different distances from the fish. Note that for piling, it is possible to determine the cumulative noise exposure as piling is a stationary noise source. Therefore the Working Group conclude that it is better to use a guideline based on the closest peak level for seismic airguns than one based on a cumulative exposure (Popper et al. 2014).

The Working Group did not propose specific behavioural guideline values due to the limited experimental data supporting previously proposed guidelines, and the specific nature of behavioural responses amongst fish species, i.e. one guideline or criteria does not fit all (Popper et al. 2014). So although there are no recommended guidelines as such, the assessment of the potential effects on behaviour is based on a study by McCauley et al. (2000), during which various fish species in large cages were exposed to a seismic airgun. Fish were recorded moving away from the source at noise levels greater than 156 to 161 dB re 1 μPa SPL (rms). However, they returned to normal behavioural patterns 14 to 30 minutes after airgun operations ceased. McCauley et al. (2000) presented an approximate conversion of the behavioural response trigger to peak pressure levels at 168 to 173 dB re 1 μPa. The higher threshold of 173 dB re 1 μPa has been used in this assessment for a strong avoidance response.

Marine Turtles

The ANSI-Accredited Standards Committee S3/SC 1, Animal Bioacoustics Working Group has proposed a guideline for mortality and potential mortal injury for marine turtles of 207 dB re 1 μPa based upon piling studies (Popper et al. 2014).

There have been no studies conducted on hearing loss or the effects of exposure to intense sounds on hearing in any turtles, therefore Popper et al (2014) have extrapolated from fish, based on the rationale that the hearing range for turtles more closely approximates to that of fishes than of any marine mammal. This is considered extremely conservative and no turtle deaths have been recorded as a result of seismic noise.

There are no specific guideline values proposed by the Working Group for behaviour due to the limitations described above (Popper et al. 2014). Therefore, the assessment of the potential effects on behaviour for marine turtles is based on a possible avoidance response of 164 dB re 1 μPa^2.s from a study conducted by McCauley et al. (2000).

Cetaceans

The underwater noise modelling has predicted "M"-weighted SELs as criteria for the effects of noise on marine mammals. M-weighting is the method whereby the signal is first weighted (filtered) relative to the hearing abilities (frequency range) of the relevant marine mammal species and the SEL or accumulated SEL is then calculated (Theobald et al. 2009).

The auditory injury (PTS-onset) and TTS/fleeing criteria described by Southall et al. (2007) were applied for mid and low-frequency cetaceans. The adopted behavioural disturbance criteria for cetaceans have been based on a severity scaling system, which ranks the behavioural response from zero for "no response" to nine for "outright panic, flight, attack of conspecifics or stranding events" (Southall et al. 2007). Severity scales of five to six are considered to have potential to affect foraging, reproduction, or survival. Specifically, a severity score of five indicates a change in swimming behaviour but not avoidance, and six (likely avoidance) indicates minor to moderate avoidance. For low and mid-frequency cetaceans a lower behavioural threshold of a score of five (possible avoidance) has been included in the assessment, due to the sensitivity of the existing environment and in order to conservatively estimate the range of potential effects.

Table 23 presents a summary of the assessment criteria used in this assessment for cetaceans and dugong.

Table 23: Summary of Injury and Behavioural Criteria for Cetaceans

Effect criteria	SEL (dB re 1 μPa^2.s)
Low-Frequency Cetaceans	
PTS-onset/injury	198 (M_{lf} weighted)
TTS-onset/ Fleeing response[1]	183 (M_{lf} weighted)
Likely avoidance of area[2]	152 [3]
Possible avoidance of area[2]	142 [3]
EPBC Act Policy Statement 2.1 Threshold	160 [4]
Mid-Frequency Cetaceans	
PTS-onset/injury	198 (M_{mf} weighted)
TTS onset/ Fleeing response[1]	183 (M_{mf} weighted)
Likely avoidance of area[2]	170 [3]
Possible avoidance of area[2]	160 [3]

Note 1: Based on the single pulse criteria for the onset of TTS in studies by Southall et al. (2007).

Note 2: Derived from Southall et al. (2007) severity scaling behavioural response. Likely avoidance indicates avoidance of the area; possible avoidance indicates a change in swimming behaviour but not avoidance.

Note 3: Derived from Southall et al. (2007) severity scaling behavioural response and converted to SEL (of the pulse) from root mean square (RMS) (over the duration of the pulse) by subtracting 10 dB for mid-frequency cetaceans and 8 dB for low-frequency cetaceans (based on the longer ranges for low-frequency cetaceans).

Note 4: Based on 160 dB re 1 μPa^2.s for 95% of shots at 1 km.

Dugong

The audible frequency range of sirenian is thought to be from 250 Hz – 90 kHz (Gerstein et al.1999; Mann et al., 2009). The most frequently detected calls are chirps (higher frequency clicks and chirps (3 to 18 kHz)), accounting for approximately 90% of all calls (Anderson and Barclay 1995). Parsons et al. (2013) recorded the source levels associated with different dugong calls, which were found to be considerably lower than those of other marine mammals were and ranged from 135 dB re 1 μPa at 1 m for barks to 158 dB re 1 μPa at 1 m for squeaks. Finneran and Jenkins (2012) developed a model to calculate the thresholds and criteria of sirenians to underwater acoustic noise; however with a lack of available studies, they proposed the threshold criteria for phocids (seals) in water be used as sirenians are considered similar in hearing range. The resulting threshold values for sirenians were then calculated as 183 dB re 1 μPa^2.s for TTS and 197 dB re 1 μPa^2.s for PTS.

Human Divers

Human divers exposed to sound levels above 154 dB re 1 μPa (SPL) in the frequency range 0.6 to 2.5 kHz reported changes in their heart rate or breathing frequency (Fothergill et al. 2001). Parvin et al. (2002) went on to propose a maximum threshold level for recreational divers and swimmers of 155 dB re 1 μPa (SPL) for the frequency range of 501 to 2,500 Hz. Diver aversion to low frequency sound has been found to be dependent upon sound pressure level and centre frequency, with the 100 Hz frequency reported as the most aversive frequency by the test subject divers (Fothergill et al. 2001; Stevens et al. 1999). The results of this study were used to propose a more conservative threshold of 145 dB re 1 μPa (SPL) for recreational divers for low frequency sound in the range of 100 to 500 Hz for which there is minimal impact predicted on the diver (Fothergill et al. 2001; Parvin et al. 2002).

The Diving Medical Advisory Committee (DMAC) is an independent body comprising diving medical specialists from across Northern Europe to provide advice on medical and safety aspects of commercial diving, and has recommended maximum sound pressure levels for commercial divers of 201 dB re 1 μPa for non-hooded divers and 211 dB re 1 μPa for hooded divers (DMAC 2011). The maximum threshold for a non-hooded diver is equivalent to the diver experiencing between 'discomfort' and 'disorientation' DMAC (2011). The DMAC guidelines for a non-hooded diver have been criticised for exceeding the threshold recommended by Parvin et al. (2002) by 46 dB in a review by Ainslee (2008). The review goes on to recommend that the threshold proposed by Parvin et al. (2002) and Fothergill et al. 2001 is more credible and should be applied, particularly for recreational and non-hooded divers (Ainslee 2008).

Schlumberger has adopted the more precautionary thresholds proposed by Parvin et al. (2002) and Fothergill et al. 2001 in this assessment.

4.4.2.3 Potential Impacts to Planktonic Invertebrates

Plankton including fish eggs and invertebrate larvae, including pearl oyster larvae, become very widely dispersed and are transported by prevailing wind and tide driven currents. They cannot take evasive behaviour to avoid seismic sources. However, the potential for population level noise effects is extremely limited due to their reduced sensitivity to noise and their widespread distribution. This means that only a small percentage of a cohort will be exposed at any one time. Invertebrate plankton species that have gas filled flotation organs (such as cephalopods) are more likely to be affected by underwater noise.

Previous studies on the effects of noise from airguns on planktonic invertebrates and fish eggs / larvae have indicated that any effect is likely to be highly localised (typically within 1.5 to 5 m of the source) (Swan et al. 1994). Any loss of plankton from an area due to noise disturbance would be anticipated only in the immediate vicinity (up to 5 m from the source) of the seismic source. The effect will be short-term with any organisms removed, quickly replaced due to their often rapid generational turnover times. Adverse effects on plankton populations are therefore deemed unlikely.

4.4.2.4 Potential Impacts to Planktonic Fish Larvae and Eggs

Sound-induced mortality in larval fish, where observed, has been in the range of 0.5 to 3 m around the source, in association with relatively high peak energy levels; however, damage may occur out to approximately 5 m (Table 24) (Payne 2009). For example, Kostyuchenko (1973) reported fish egg mortality out to 0.5 m and only pathological effects (e.g. embryo curling, membrane perturbation and yolk displacement) at 5 m in a small percentage of anchovy eggs exposed to an estimated source level of 230 dB re 1 μPa. Matishov (1992) observed delamination of the retina in cod larvae within 1 m of a seismic source with a level of 250 dB re 1 μPa (peak to peak). Booman et al. (1996) recorded the highest mortality rates of Norwegian fish eggs and larvae within 1.4 m and low or no mortality and infrequent pathology within 5 m of the seismic source. In contrast, Dalen and Knutsen (1987) exposed cod eggs, larvae and fry to a single seismic discharge with a source level of 220 dB re 1 μPa (SPL) and no effects were observed at either 1 m or 5 m. A recent study by the Institute for Marine Resources and Ecosystem Studies (Bolle et al. 2012) also observed no statistically significant effect on the survival rate of common sole larvae exposed to piling noise at doses of a peak SPL of 210 dB re 1 μPa and cumulative SEL dose of 206 dB re 1 μPa^2.s.

Table 24: Observed Seismic Noise Pathological Effects on Fish Eggs and Larvae

Species	Source	Source Level (dB re 1 μPa at 1 m)	Distance from Source (m)	Exposure Level (dB re 1 μPa)	Observed Effect	Source
Cod (larvae 5 days)	Single airgun	250	1	250	Delamination of the retina	Matishov (1992)
Cod (larvae 2–10 days)	Single airgun	222	1	222	No injuries detected	Dalen and Knutsen (1986)
			10	202	No injuries detected	
Fish eggs (anchovy)	Single airgun	230 (estimated)	1	230	7.8% of eggs injured relative to control	Kostyvchenko (1973)
			10	210	No injuries detected	
Fish eggs (red mullet)			1	230	No injuries detected	
			10	210	No injuries detected	
Dungeness crab (larvae)	Seven airgun array	244 (estimated)	1	233.5	No significant difference in survival rate relative to controls	Pearson et al. (1994)
			3	230.9		
			10	222.5		
Snow crab (eggs)	Single airgun	216	2	216	1.6% mortality; 26% delay in development	Christian et al. 2004

The WA DoF has identified through the stakeholder consultation process (Table 15) that several valued finfish species may spawn in the area in which the survey is planned. Goldband snapper (*Pristipomoides multidens*) and red emperor (*Lutjanus sebae*) have wide distributions across the NWS and tend to occupy and spawn in habitats that are expansive throughout the region (Newman et al. 2003). Pink snapper (*Pagrus auratus*) are found in coastal Australians waters from Karratha in Western Australia through South Australian, Victorian and New South Wales waters to Southern Queensland (DoF 2011a). Rankin cod (*Epinephelus multinotatus*) are broadly distributed across Indo-Pacific region and likely to have a broad spawning period (August to October) with discrete peaks in spawning (Robinson et al. 2008). Spanish mackerel (*Scomberomorus*

commerson) are broadly distributed across Indo-Pacific region and spawn over a period of several months in the Kimberley region (Mackie et al. 2005).

An important study, although limited in scope, investigated the consequences seismic-induced mortality may have at a population level (Sætre and Ona 1996). The work was based on the observed mortality figures for larvae and fry at given distances in Booman et al. (1996) for five species of fish (cod, saithe, herring, turbot, and plaice). As a "worst case" situation, it was estimated that the number of larvae killed during a typical seismic survey (>10 days) was 0.45% of the total larvae population (Sætre and Ona 1996). When compared with very high natural mortality rates for species (e.g. cod and herring eggs/larvae have a natural mortality of 5 to 15% per day), the potential loss associated with a seismic survey is negligible.

Studies to date that have investigated the effects of noise from airguns on fish and invertebrate eggs / larvae have indicated that any effect is likely to be highly localised (typically within 1.5 to 5 m of the source) and very small when compared to total population sizes, mortality rates or events such as storms, cyclones or natural shifts in oceanographic patterns (Swan et al. 1994). Since the Operational Area makes up a very small proportion of the overall area in which these as well as other species identified by DoF in Table 15 spawn, there is no indication that the Operational Area includes any important fish spawning sites, and the effects will be much localised, seismic activity is unlikely to impact the spawning stock biomass. The risk therefore of mortality of fish and invertebrate eggs / larvae is considered restricted to the immediate vicinity of the seismic source (<5 m) and population level effects are significantly reduced by larval drift in surface currents and the moving source. This will have no effect on the environmental values of the Ningaloo World Heritage Area (WHA) which include *"maintaining the abundance and size composition of finfish species in sanctuary zones and conservation areas at natural levels"*.

4.4.2.5 Potential Impacts on Coral Spawning

There have been no direct studies on the effects of underwater noise from seismic surveys on coral spawning as such, as the majority of studies have studied effects on coral reef communities in general, largely focussing on the effects on coral reef species. However, it can be reliably assumed that coral spawn would be affected in a similar way to fish larvae and other planktonic organisms (fish eggs, invertebrates), which freely drift in the water column. Planktonic larval mortality, where observed, has been in the range of 0.5 to 3 m around sources with relatively high peak energy levels (e.g. seismic, piling) (Kostyuchenko 1973; Dalen and Knutsen 1987; Bolle et al. 2012); with some studies reporting damage potentially occurring out to approximately 5 m (Davis et al. 1998; Payne 2009). Therefore, any effect on planktonic organisms (including coral larvae) is likely to be highly localised (i.e. typically within 5 m of the source), short-term and very small when compared to total population sizes, mortality rates or natural events such as storms, cyclones or natural shifts in oceanographic patterns.

4.4.2.6 Potential Impacts to Shellfish and Other Invertebrates

The potential for shellfish and other marine invertebrates such as crustaceans, to suffer serious impacts from sound (e.g. hearing damage) is limited because morphological structures that are stimulated by the pressure component of sound have not been discovered in marine invertebrates. They appear to be most sensitive to the vibrational component of sound and statocyst organs may provide one means of vibration detection for these species. There is also evidence to suggest that some species of cephalopods, in particular, are susceptible to high intensity, low-frequency underwater noise (André et al. 2011).

As a result of the physiology of shellfish (and other marine invertebrates), over-stimulation and pathological damage can only occur when in very close proximity to the source (less than a few metres) (McCauley 1994). The response at close range to a seismic pulse is likely to be limited to a "tail flip" avoidance response from crustaceans or a closing of siphons in sponges (McCauley 1994). The transient nature of the disturbance as the seismic source moves away along the sail line further reduced the potential for impacts.

A study investigating the effect of seismic explosions (not airguns) on pearl oysters (*Pinctada maxima*) by Le Provost et al. (1986) at the Lowendal Islands showed that trialled seismic explosions caused mortality in some, but not all, oysters within 1 m of the source. There was no effect on pearl oysters at 10 m or more from the seismic source. The study further concluded that over a period of seven months, there was no attributed mortality of pearl oysters because of seismic activities.

Hirst and Rodhouse (2000) have suggested that most invertebrates would only detect seismic shots within about 20 m. Two studies that observed catch levels of shrimp and lobster in areas surveyed with airguns reported no change during surveys (Hirst and Rodhouse 2000). A study conducted in 2002 examined a number of health, behavioural, and reproductive variables

before, during, and after, seismic shooting on snow crabs (*Chionoecetes opilio*). Experimental animals were exposed to peak received broadband sound levels of 201 to 237 dB re 1 μPa. The results of the study suggested no obvious effects on crab behaviour, health or catch rates (Christian et al. 2004).

Few marine invertebrates have sensory organs that can perceive sound pressure, but many have organs or elaborate arrays of tactile "hairs" that are sensitive to hydro-acoustic disturbances (McCauley 1994). These sensory hairs or organs are collectively known as mechanoreceptors, and crustaceans are particularly well endowed with them. Close to a seismic source, the mechano-sensory system of many benthic crustaceans will perceive the "sound" of airgun pulses, but for most species such stimulation would only occur within the near-field or closer, perhaps within distances of several metres from the source (McCauley 1994). They will not be exposed to this level of noise during the current survey.

La Bella et al. (1996) examined biochemical indicators of stress in bivalves exposed to seismic airgun noise. In this study, they found that hydrocortisone, glucose and lactate levels between test and control animals were significantly different ($P > 0.05$) in the venerid clam *Paphia aurea*, showing an evidence of stress caused by acoustic noise. This was measured at an exposure distance of 7.5 m.

A more recent study conducted by the Tasmanian Aquaculture and Fisheries Institute (TAFI) assessed the immediate impact of seismic surveys on adult commercial scallops (*Pecten fumatus*) in the Bass Strait (Harrington et al. 2010). During late 2009, fishers who participate in the Bass Strait Central Zone Scallop Fishery (BSCZSF) were informed by the Australian Fisheries Management Authority (AFMA) of two seismic surveys, to be conducted within eastern Bass Strait during early 2010. The area selected for seismic testing was known to support significant beds of commercial scallops. Participants in the BSCZSF were concerned that this seismic surveying may have a negative impact on the adult scallops within the proposed survey region. In response to this concern from industry, TAFI was commissioned by AFMA to undertake a before and after study of the effects of the seismic survey on the target species.

The TAFI study concluded that no short-term (< two months) impacts on the survival or health of adult commercial scallops were detected after the seismic survey (Harrington et al. 2010). There had been no change in the abundance of live scallops (or related change in dead scallop categories) or macroscopic gonad and meat condition was detected after seismic surveying within either the control, impacted or semi-impacted strata. There was also no observable change in the size frequency distribution of scallops in the impacted and semi-impacted strata following the survey.

Effects on marine invertebrates are therefore expected to be limited in spatial extent, as they are considered less sensitive to noise than hearing-specialist fish species, due to the lack of air-filled organs. It is likely that bivalves, such as the pearl oyster and crystal crab, would have to be within a very close range of an airgun source to experience pathological damage or mortality (<10 m as reported by Le Provost et al. (1986)). Potential injury and/or behavioural effects would therefore be much lower for shellfish and other crustaceans and would not be expected to be beyond the injury and behavioural response ranges presented for fish species.

4.4.2.7 Potential Impacts to Other Fish Species (Including Commercial Species)

Underwater noise levels significantly higher than ambient levels can have a negative impact on fish, ranging from physical injury or mortality, to temporary effects on hearing and behavioural disturbance effects. The hearing system of most fishes is sensitive to sound pressures between 50 and 500 Hz, the lower end of which (<200 Hz) overlaps the predominant frequency range of seismic noise emissions (Ladich 2012; McCauley et al. 2000). Sound is perceived by fish through the ears and the lateral line (the acoustico-lateralis system) which is sensitive to vibration.

The effects of underwater noise on fish within the vicinity of the Exmouth SLB15 MC3D MSS will vary depending on the size, age, sex and condition of the receptor among other physiological aspects, and the topography of the benthos, water depth, sound intensity and sound duration. The effect of noise on a receptor may be either physiological (e.g. injury or mortality) or behavioural. Behavioural changes are expected to be localised and temporary, with displacement of pelagic or migratory fish likely to have insignificant repercussions at a population level (McCauley 1994).

Fish have been divided into three broad groups based on hearing sensitivity – fish without swim bladders, fish with swim bladders that are not involved in hearing (hearing generalists), and fish with swim bladders that are involved in hearing or pressure detection (hearing specialists). Distinctions between the groups are based on whether the species have specialised organs for improving sound reception. Some species of teleost or bony fish (e.g. herring *Clupea harengus*) have a structure linking the gas-filled swim bladder and ear and these species usually have increased hearing sensitivity up to 500 Hz and can

hear sounds over a broader range of frequencies (50 to >3,000 Hz). The swim bladder is sensitive to the pressure component of a sound wave, which it resonates as a signal that stimulates the ears (Hawkins 1993). Hearing specialists are more sensitive to anthropogenic underwater noise sources than hearing generalists such as cod (*Gadhus* spp.), which do not possess a structure linking the swim bladder and inner ear. Fish species that either do not possess a swim bladder (e.g. sharks, rays, mackerels and tunas) or have a much-reduced swim bladder (e.g. flatfish) tend to have relatively low auditory sensitivity.

Injury

Fisheries and Oceans Canada ran workshops with relevant scientific experts and regulators to discuss documented effects of seismic noise on marine fauna in 2003 and 2004. It then commissioned teams of scientists to prepare major literature reviews of experimental and field studies and international standards and mitigation methods. These papers were reviewed at a National Advisory Process meeting on Seismic Impact Evaluation Framework in May 2004 (DFO 2004). It specifically looked at the potential impacts of seismic noise on fish and other marine fauna to guide its assessment and regulation of such activities. Recognising the lack of empirical data on seismic sound impacts, the review was broadened to include evidence for underwater noise impacts from other sources.

The key outcomes of the Seismic Impacts Evaluation Framework workshop were:

- No fish kills due to seismic surveys have been documented, despite extensive seismic survey activity around the world.
- In Canada, seismic surveys have frequently had 'follow vessels' looking for fish kills, but none have been observed.
- While it is possible that fish kills would be undetected, other causes of fish kills have had clearly observable effects.
- Exposure to seismic sound is considered unlikely to result in direct fish mortality.
- Seismic noise has documented behavioural effects on fish which can affect their catchability during a seismic survey (note: these behavioural changes enable fish to reduce their exposure to the seismic sound). These behavioural responses include:
  - Startle response (avoidance)
  - Changes in swimming patterns and directions
  - Changes in vertical distribution
  - Changes in horizontal distribution.

A more recent workshop to re-examine the same questions, found that there was still a dearth of directly relevant data on seismic noise impacts on fish and still no documented cases of fish kills during seismic surveys or in experimental studies replicating seismic sound fields. The outcomes of the recent workshop are documented in Popper et al. (2014).

Popper et al. (2014) acknowledge that there are still few data regarding the effects of seismic airgun noise on fish mortality and damage to organ systems. They also cite studies on seismic sound effects on fish and state that no studies have linked mortality of fish, with or without swim bladders, to seismic noise (Popper et al. 2005; Boeger et al. 2006; Popper et al. 2007; Hastings et al. 2008; Halvorsen et al. 2011, 2012; Casper et al. 2012; McCauley and Kent 2012; Miller and Cripps 2013; and Popper et al. 2015). They stress that the nominal thresholds for fish injury and mortality presented in their review (SPL_{peak} of 207 213 dB re 1 μPa; for fish with and without swim bladders respectively) should not be used as firm criteria. While these thresholds are the only ones tentatively nominated to date, and therefore by default the best available, clearly they must be used cautiously. They can greatly over-estimate the level of potential impact if taken at worst-case effect for a listed range of potential effects and increase Type I error in impact assessment.

Empirical evidence comes from a recent study by Wagner et al. (2015) which exposed gobies to seismic sound at a level greater than the mortality and potential mortality threshold proposed by the Popper et al. (2014). The fish were exposed to six discharges at an average peak SPL of 229 dB re 1 μPa. Fish were monitored for 60 hours post exposure and no mortality or significant physiological damage (hair cell loss or otolith damage) were observed. In another study, individuals of four fish species were exposed to piling noise levels above a peak SPL of 207 dB re 1 μPa, but did not suffer any mortal or potentially mortal injuries (Casper et al. 2012).

A study by McCauley et al (2003) found evidence of damage to sensory hair cells in the ears of snapper exposed to around 212 dB re 1 μPa in a caged trial. However, sensory hair cells are constantly added in fishes (Popper and Hoxter 1984;

Lombarte and Popper 1994) and are also replaced when damaged (Lombarte et al. 1993; Smith et al. 2006; Schuck and Smith 2009). Therefore, any impacts to the hair cells of fish that could not avoid the seismic source would be temporary.

A study on four tropical fish species at Scott Reef using a 2,055 in^3 airgun array and caged fish which could not avoid the seismic noise, found no temporary threshold shift (TTS) (i.e. temporary injury) even after exposure to a cumulative SEL of 190 dB re 1μPa^2.s (Hastings et al. 2008). The species studied included a hearing specialist, the pinecone soldierfish (*Myripristis murdjan*). The pinecone soldierfish has an air-filled chamber directly adjacent to its ear, which functions much like the eardrum in mammals. This special anatomy makes the pinecone soldierfish particularly sensitive to sound at frequencies over a broader range than the other fishes (Hastings et al. 2008). The other three fish species (blue green damselfish (*Chromis viridis*), sabre squirrelfish (*Sargocentron spiniferum*) and bluestripe seaperch (*Lutjanus kasmira*)) are hearing generalists. Soldierfish, squirrelfish, and damselfish are site-attached reef fish that would not be expected to leave their immediate habitats to avoid high-level sounds. The bluestripe seaperch, a tropical snapper, is a pelagic fish that could be expected to swim away from an approaching seismic survey vessel with an operating airgun array.

Behaviour

Pelagic species within the Operational Area are highly mobile, and are likely to move away from the source if the received sound levels become uncomfortable. Therefore, physiological impacts to pelagic species are not expected to occur. Demersal species may be less inclined to move away from sound sources than pelagic species, particularly if "site-attached" species are present due to territorial behaviour and site fidelity (Wardle et al. 2001).

A range of responses has been observed when the behaviour of wild fish species has been studied in the presence of anthropogenic sounds. Some fishes have shown changes in swimming behaviour and orientation, including startle reactions (Pearson et al. 1992; Wardle et al. 2001; Hassel et al. 2004). Sound can also cause changes in schooling patterns and distribution (Pearson et al. 1992). However, researchers have observed that once acoustic disturbances are removed, fish return to normal behaviour within about an hour (McCauley et al. 2000; Pearson et al. 1992; Wardle et al. 2001).

Trials with captive fish indicate that some species exhibit alarm and avoidance responses to seismic discharges, such as swimming faster, swimming to the bottom of the cage, and tightening of school structure (McCauley et al. 2000). The tightening of school structure behaviour suggests the survey is unlikely to affect adversely the aggregation behaviour of spawning fish. These trials also indicate the following:

- fish generally show little evidence of increased stress from exposure to seismic signals unless restricted from moving away from the source
- fish may become acclimatised or habituated to seismic signals over time and the severity of the startle responses decreases with exposure time
- no significant measured stress increases (blood cortisol concentrations) which could be directly attributed to airgun exposure.

Behavioural observations of captive fish and squid were made before, during and after air gun noise exposure in a study carried out by Fewtrell and McCauley (2012). The results indicated that as air gun noise levels increase, fish respond by moving to the bottom of the water column and swimming faster in more tightly cohesive groups. In addition, behavioural responses such as fish huddling in groups and swimming towards the lower part of the water column in response to air gun noise have been observed in studies by Chapman and Hawkins, (1969), Dalen and Knutsen (1987), Dalen and Raknes (1985) and Slotte et al. (2004).

Field studies of seismic sound impacts on fish behaviour and health have mostly looked at the effects on caged fish (e.g. Boeger et al. 2006; McCauley and Kent 2012). These studies found no mortality and little evidence of physiological damage due to exposure to a lower powered seismic source. A more relevant study was undertaken by Miller and Cripps (2013) to investigate the effects of seismic surveys on open (wild) coral reef fish communities, including site-attached fish species from the family Pomacentridae. Pomacentrid fish are coral obligates and are truly site-attached in the sense that CGG uses it in the EP to represent fish that are less able to escape an approaching airgun. The study found no evidence of direct mortality or indirect mortality due to sub-lethal effects in site-attached pomacentrid fish exposed to a seismic source level of 200 dB re 1 μPa^2.s SEL_{cum}. The seismic sound had no measurable effect on the diversity and abundance of the shallow reef fish community at Scott Reef. The authors concluded that the effect of the seismic survey was clearly non-lethal and there was no statistical evidence of an impact on either the diversity or abundance of shallow water, coral reef slope, fish communities

(Miller and Cripps 2013). Another, related field experiment exposed caged reef fish to the same seismic source in approximately 5 m of water. The caged fish did not suffer any direct mortality, soft tissue damage, or permanent or temporary hearing threshold shifts (Woodside 2007; Hastings and Miksis-Olds 2012).

Underwater Noise Modelling Assessment

The impact ranges (distance from source) for fish for mortality, injury and behaviour derived from the noise modelling data are presented in Table 25 and Figure 6. The ranges reflect the non-circular nature of the sound energy emissions from the source, which is also apparent from the long range model outputs shown in Figure 4 (Section 4.4.2.1). The received levels represent the worst-case or maximum levels for fish species at any depth in the water column; from the sea surface to the seabed.

The criteria for "mortality and potential mortal injury" and "recoverable injury" are the same; indicating that a range of effects could be observed. These effects are predicted to occur within 117 to 172 m of the source for fish without swim bladders and within 190 to 305 m (Table 25) for fish with swim bladders from a source located in shallow water (31 m) adjacent to the boundary of the Ningaloo WHA. However, it should be noted that mortality is unlikely to occur even at the highest noise levels, and instead a range of effects is predicted; from recoverable injuries to permanent injuries that are not likely to result in death. Mortality of fish (pelagic or site-attached) is not expected to occur because no studies have demonstrated seismic airgun noise causes fish mortality and damage to organ systems, and there is no evidence from seismic survey observations of fish with swim bladders suffering mortality to date (Popper et al. 2007; Hastings et al. 2008; and McCauley and Kent 2012). In the absence of real threshold for mortality, nominal guidelines for mortality have been extrapolated from recoverable injury levels from piling noise studies (Halvorsen et al. 2011; Popper et al. 2014).

Behavioural effects in fish (strong behavioural avoidance) are predicted to occur from 605 to 2,565 m from the seismic source (Table 25). The behavioural response predicted may be sufficient to result in temporary avoidance by mobile fish species up to 3 km (rounded up to be more conservative in terms of inherent uncertainty in modelled predictions) as the vessel approaches; however, once the vessel has moved outside of this distance, fish are likely to resume normal behaviour and distribution within the area within 30 minutes (McCauley et al. 2000).

The majority of fish populations within the Operational Area are mobile pelagic fish species, which are expected to avoid the approaching seismic noise source actively well before it reaches the range within which physiological effects may be realised. In natural situations, the great majority of fish species are expected be able to avoid the approaching noise source before it reaches injurious or potentially lethal levels through horizontal or vertical movements. Evidence that fish can actively avoid the source comes from studies describe in this assessment of caged fish actively swimming away from the approaching noise source, as well as temporarily reduced catchability in commercial fisheries. Wardle et al. (2001) conducted a field study, using a video camera to document the behaviour of fish in response to noise levels equivalent or greater than those for the Exmouth SLB15 MC3D MSS. This study showed that the resident fish did not evade the active source until it was within a few metres. No direct mortality was observed at sound levels of up to 218 dB (SPLpeak).

The seismic vessel will not operate in shallow water within the Operational Area or directly over shallow reefs where site-attached fish species occur, as the shallowest water depth that the vessel will operate is 30 m (which makes up a very small proportion of the operational area, 1.72 km^2 or <0.004% of the total Operational Area), with the majority of data acquisition in >50 m water depth (>99%). The noise modelling shows that noise levels reaching shallow reefs, for example around the Muiron Islands (5.8 km from the closest edge of the Operational Area) will be below the impact threshold for fish with or without swim bladders.

The most likely major effect would see fish either swimming away from the airgun source or simply retreating to the relative shelter of the reef as they would normally, upon the approach of large predators (Miller and Cripps 2013). Once the source of the stimulus passed fish would likely resume their normal behaviour. No population level effects are predicted for fish species of commercial and recreational importance and no impact is expected on the values of the Ningaloo WHA / CMR / MP or the Muiron Islands MMA, nor on the productivity and high diversity of the Continental Slope Fishery KEF and Canyons linking the Cuvier Abyssal Plain with the Cape Range Peninsula KEF. In addition, noise pollution has not been identified as a pressure of concern for either KEF (Commonwealth of Australia 2012).

Table 25: Summary of Impact Ranges for Fish at Source Site 1 for a 3,147 in^3 Airgun Array Volume

Fish Group	Guideline Description	Guideline Value (dB re 1 μPa, SPLpeak)	Impact Range
Fish: no swim bladder	Mortality and potential mortal injury	>213	117 – 172 m
	Recoverable injury		
Fish: swim bladder is NOT involved in hearing	Mortality and potential mortal injury	>207	190 – 305 m
	Recoverable injury		
Fish: swim bladder IS involved in hearing	Mortality and potential mortal injury	>207	190 – 305 m
	Recoverable injury		
Fish behaviour (all groups)	Strong avoidance	173	605 – 2,565 m

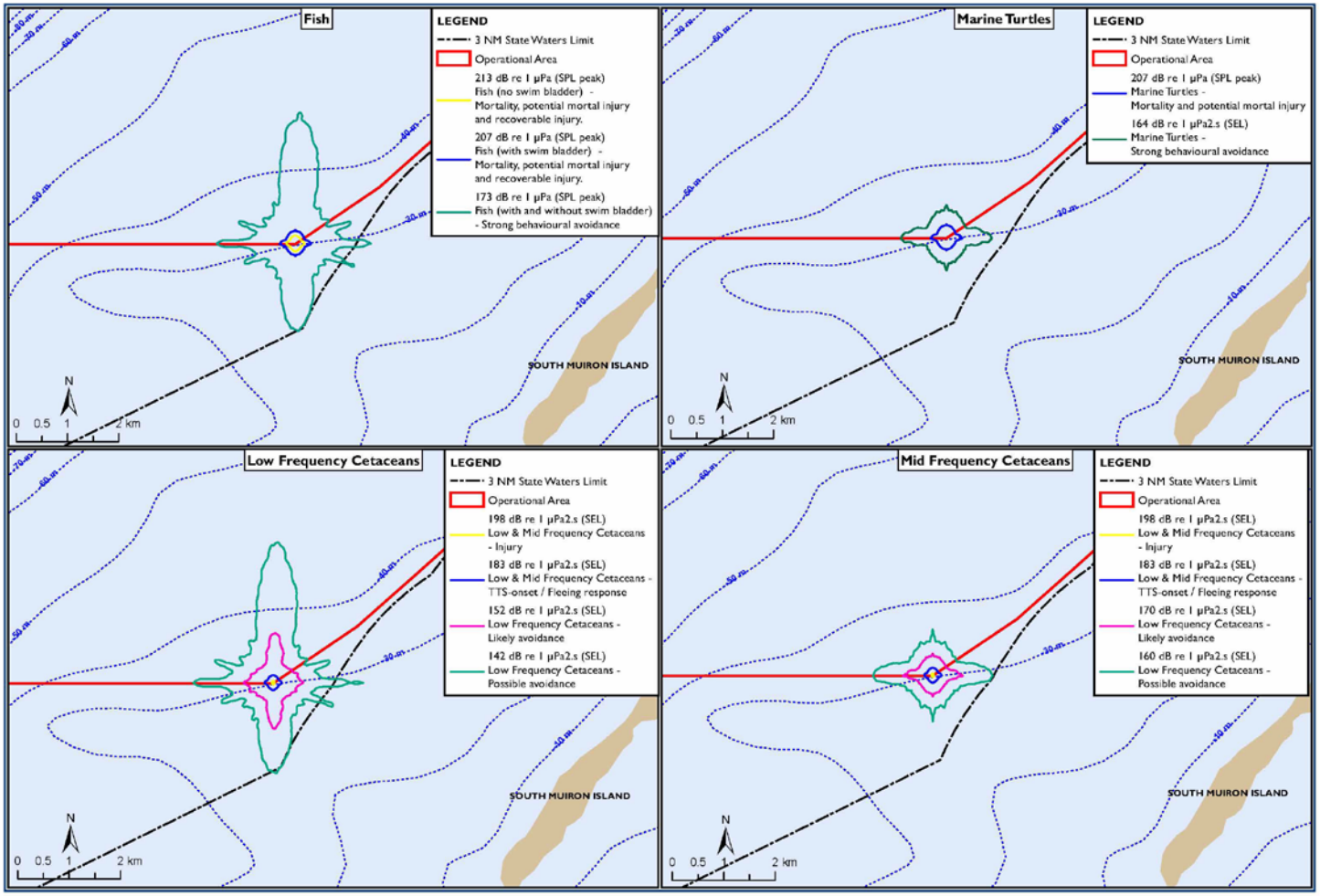


Figure 6: Modelled received sound levels for Cetaceans (and Dugong), Marine Turtles and Fish (including Whale Sharks) for a 3,147 in^3 airgun array

4.4.2.8 Potential Impacts to Cetaceans and Dugong

Marine mammals use sound for foraging, orientation, communication, navigation, echolocation of prey and predator avoidance (Richardson et al. 1995) and therefore are sensitive to underwater noise. High levels of anthropogenic underwater sound can potentially have negative impacts; ranging from changes in their acoustic communication, displacing them from an area, and in more severe cases causing physical injury or mortality (Richardson et al. 1995).

Theoretically, the high peak pressure sound levels very close to a seismic source have the potential to cause death, or severe injury leading to death of cetaceans. Some of these effects may be considered barometric pressure effects due to the shock experienced by the animal, rather than acoustic effects per se. However, limited information is available regarding the sound levels at which hearing damage or physical injury occurs in cetaceans and it is extremely unlikely they will be close enough to the active airgun for such effects.

High levels of noise exposure can also cause an instantaneous auditory injury resulting in a permanent threshold shift (PTS) that persists once sound exposure has ceased. PTS may also result from prolonged exposure at lower levels. Hearing loss may be considered permanent if hearing does not return to normal after several weeks. Lower noise levels or shorter exposures to noise have the potential to cause a temporary threshold shift (TTS) where animals would experience temporary auditory injury, and from which they would recover fully, particularly as they move away from the source.

The relationship between these two thresholds is complex since PTS can either be induced by a single high level noise exposure or by chronic (longer term) noise exposure at lower levels (Southall et al. 2007). The threshold for auditory injury is therefore taken as the levels at which PTS starts to occur, based on the overall noise dose received over time, and is termed the PTS-onset criteria. Given that PTS cannot be ethically or legally induced in animals to determine the threshold, Southall et al. (2007) proposed that noise exposure criteria for PTS-onset should be extrapolated from the onset of TTS based on the assumed relationships between the relative levels of noise likely to cause TTS and PTS. This provides a very conservative estimate of the noise levels likely to induce permanent auditory injury, however, not all animals exposed to this level will experience PTS.

The level at which TTS-onset occurs is also precautionary as it assumes that the hearing of all animals within a group (with hearing sensitivity to the same range of frequencies) will be affected in the same way. For example, Gedamke et al. (2011) identified a TTS in hearing for one beluga whale at 186 dB re 1 μPa^2.s and no TTS was observed in one bottlenose dolphin at approximately 188 dB re 1 μPa^2.s. The ecological effect of TTS depends on the magnitude of the TTS, its duration (depending on the exposure duration), the recovery time after the exposure stopped, the frequency at which hearing is affected and whether this frequency is important, for example, for echolocation (Kastelein et al. 2013). The most likely response of marine mammals to noise levels that could induce TTS is to flee from the area (Southall et al. 2007). Subsequently, the onset of TTS is referred to as the “fleeing response” threshold in the underwater noise modelling assessment within this EP. As an animal flees an area, its exposure to the noise level decreases and therefore the likelihood of TTS (and PTS) is reduced.

In considering behavioural responses in cetaceans, Southall et al. (2007) discussed a range of likely behavioural reactions that may occur. These include orientation or attraction to a noise source, increased alertness, modification of characteristics of their own sounds, cessation of feeding or social interaction, alteration of movement/diving behaviour, temporary or permanent habitat abandonment and in severe cases, panic, flight stampede or stranding. Behavioural effects may result in animals being displaced from preferred foraging grounds to potentially less optimal areas, experiencing increased competition or greater energy costs associated with finding food. The effect may be a reduction in the individual’s long-term fitness and survival.

For example, behavioural responses to low frequency acoustic sound in baleen whales range from tolerance at low–moderate acoustic levels (McCauley et al. 2000) to graduated behavioural responses including shifts in respiratory and diving patterns (McCauley 1994) at higher levels. It has been observed that the behaviour of cetaceans to differing sound levels depends on their activity at the time of exposure and is variable between and within species (Richardson et al. 1995). Cetaceans tend to be less responsive to sound when migrating or feeding than when suckling, resting or socialising. Behavioural responses to low frequency sounds like seismic airgun discharges include:

- minor to moderate behavioural responses have been observed in migrating (McCauley et al. 1998) and in socialising (McCauley et al. 2000) humpbacks at received SPL of between 140 and 180 dB re 1 μPa

- startle response when a resting or slow moving whale rapidly moves away from the sound source or changes surface – dive – respiration behaviour
- avoidance by a course or speed change to maintain a minimum buffer distance to the sound source (observed in grey and bowhead whales at 150 to 180 dB re 1 μPa sound level contour (Richardson et al. 1995)
- swimming directly to the source up to a stand-off point
- changes to vocalisation patterns.

The hearing sensitivity of the animal is taken into account with a frequency weighting applied to the received levels. The hearing thresholds of marine mammals vary between species. Hearing sensitivity is based on both the frequency range of marine mammals and their threshold of hearing (i.e. the level of sound at which they perceive noise). Based on current knowledge of functional hearing in marine mammals, Southall et al. (2007) defined five distinct functional groups based on the frequency range at which their hearing is most sensitive; a) low frequency cetaceans (7 Hz to 22 kHz), b) mid-frequency cetaceans (150 Hz to 160 kHz), c) high frequency cetaceans (200 Hz to 180 kHz), d) pinnipeds in water (75 Hz to 75 kHz) and e) pinnipeds in air (75 Hz to 30 kHz).

The key marine mammal species within the Exmouth SLB15 MC3D MSS Operational Area that may be affected by underwater noise from seismic operations have been classed into the functional hearing groups as follows:

- low-frequency cetaceans (baleen whales): humpback, pygmy blue, Bryde's, Antarctic minke whales.
- mid-frequency cetaceans: limited to transiting individuals for killer whales, dolphins (Indo-Pacific humpback dolphins) and dugong.

Frequency weighting for the marine mammal groupings identified above provides a sound level referenced to an animal's hearing ability for either individual species or classes of species, and therefore a measure of the potential of the sound to cause an effect. The measure that is obtained represents the perceived level of the sound for that animal. This is an important consideration because even apparently loud underwater sound may have no effect on an animal if it is at frequencies outside the animal's hearing range.

The PMST identifies the following threatened, migratory, listed cetacean species potentially occur in the operational area and identifies the hearing group each belong based on Southall et al. (2007) (see Table 26).

Table 26: Threatened, migratory and listed cetaceans possibly occurring in Operational Area

Species name	Common name	EPBC Act status	Hearing group*
Balaenoptera musculus	Blue whale	Endangered and migratory	**Low**
Eubalaena australis	Southern right whale	Endangered and migratory	**Low**
Megaptera novaeangliae	Humpback whale	Vulnerable and migratory	**Low**
Balaenoptera bonaerensis	Antarctic minke whale, dark-shoulder minke whale	Migratory	**Low**
Balaenoptera edeni	Bryde's whale	Migratory	**Low**
Orcinus orca	Killer whale, orca	Migratory	**Mid**

Physeter macrocephalus	Sperm whale	Migratory	**Mid**
Sousa chinensis	Indo-Pacific humpback dolphin	Migratory	**Mid**
Tursiops aduncus (Arafura/Timor Sea populations)	Spotted bottlenose dolphin (Arafura/Timor Sea)	Migratory	**Mid**
Balaenoptera acutorostrata	Minke whale	Listed	**Low**
Tursiops truncatus s. str.	Bottlenose Dolphin	Listed	**Mid**
Ziphius cavirostris	Cuvier's Beaked Whale, Goose-beaked Whale	Listed	**Mid**
Stenella longirostris	Long-snouted Spinner Dolphin	Listed	**Mid**
Steno bredanensis	Rough-toothed Dolphin	Listed	**Mid**
Tursiops aduncus	Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin	Listed	**Mid**
Stenella attenuata	Spotted Dolphin, Pantropical Spotted Dolphin	Listed	**Mid**
Stenella coeruleoalba	Striped Dolphin, Euphrosyne Dolphin	Listed	**Mid**
Mesoplodon densirostris	Blainville's Beaked Whale, Dense-beaked Whale	Listed	**Mid**
Peponocephala electra	Melon-headed Whale	Listed	**Mid**
Sousa chinensis	Indo-Pacific Humpback Dolphin	Listed	**Mid**
Grampus griseus	Risso's Dolphin, Grampus	Listed	**Mid**
Kogia breviceps	Pygmy Sperm Whale	Listed	**High**
Kogia simus	Dwarf Sperm Whale	Listed	**High**
Lagenodelphis hosei	Fraser's Dolphin, Sarawak Dolphin	Listed	**Mid**
Feresa attenuata	Pygmy Killer Whale	Listed	**Mid**
Globicephala macrorhynchus	Short-finned Pilot Whale	Listed	**Mid**
Delphinus delphis	Common Dolphin, Short-beaked Common Dolphin	Listed	**Mid**
Balaenoptera acutorostrata	Minke Whale	Listed	**Low**

*Southall et al. (2007).

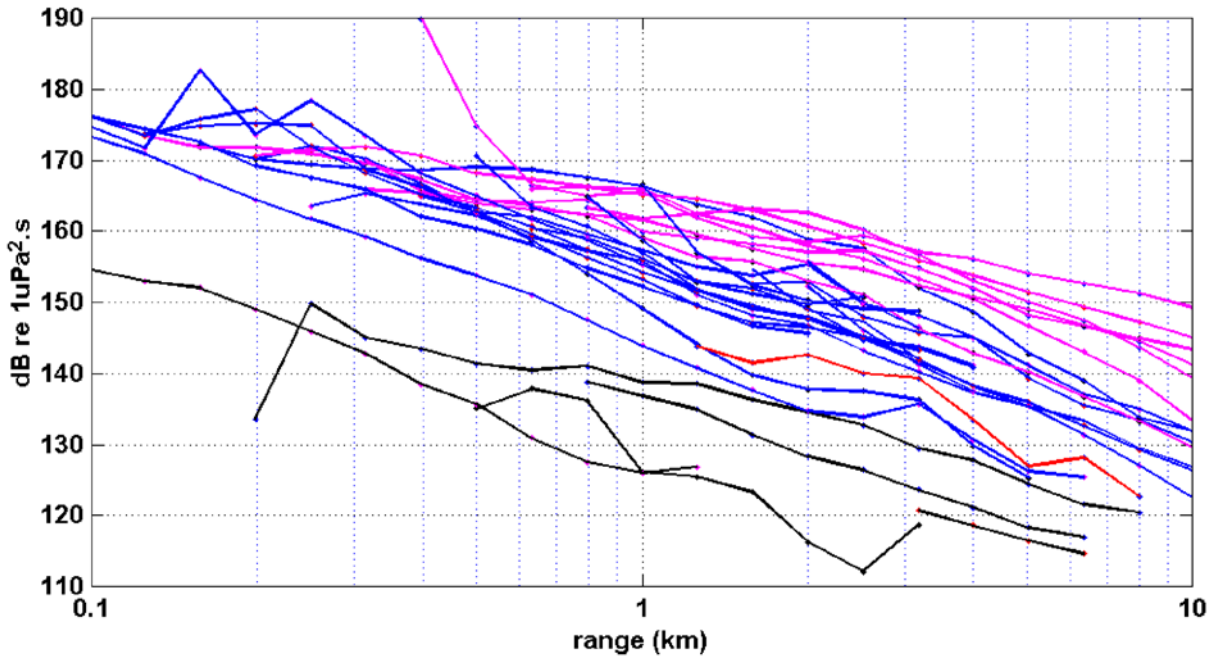
Low and Mid Frequency Cetaceans – Injury, PTS and TTS Ranges

The results of the noise modelling for the 3,147 in^3 array have been used to determine impact ranges for low and mid-frequency cetaceans (Table 27 and Figure 6). The received levels represent the worst-case or maximum levels at any depth in the water column. The impact ranges indicate that injury / PTS-onset would only occur in animals extremely close to the seismic source (18 to 50 m from a seismic source in shallow (31 m) water and adjacent to the boundary of the Ningaloo WHA). Impact ranges for TTS-onset are also very small and are predicted to occur within 110 to 170 m of the seismic source (Table 27). However, it is considered highly unlikely that a cetacean would be exposed to these levels due to the implementation of the shut-down precautionary zone of 500 m as required under EPBC Policy Statement 2.1. It is therefore unlikely that an animal will be within this range of the seismic vessel at the commencement of the survey as pre-start visual observations would be carried out for 30 minutes prior and then soft-start procedures ramping up the airgun array power over a period of 30 minutes would encourage the animal to move away. Shut-down and/or low power zones will be implemented for whales that do not avoid the vessel to avoid injury (Table 30). Furthermore, operationally, the airgun will always be greater than 500 m from the Ningaloo Coast WHA boundary, which will provide a buffer along the WHA boundary and there will be no threat to the values of the Ningaloo WHA, namely no loss of marine fauna diversity.

Low and Mid-Frequency Cetaceans – Behavioural Disturbance Ranges

Modelling results predict that the EPBC Act Policy Statement 2.1 threshold of 160 dB re 1 μPa^2.s for 95% of shots at 1 km would be reached within 1 km of the 3,147 in^3 airgun array in some directions, particularly along azimuths in deeper water. The 160 dB SEL threshold is reached at a distance of between 495 and 1,165 from source site 1 (Table 21). These results are consistent with empirical measurements of various seismic airgun sources in western and southern Australian waters (Dr Rob McCauley, CMST Curtin University June 2009), in which the sound pulses from airgun arrays between 2,000 and 3,000 in^3 are expected to decrease to around 160 dB re 1 μPa^2.s or lower within 1 km of the source (Figure 7). In accordance with EPBC PS2.1, a greater standard precaution zone for low-power of 2 km will be implemented for the survey (Table 30).

In terms of a behavioural response in low frequency cetaceans, levels at which likely avoidance could occur are predicted up to 340 – 975 m from the source and possible avoidance (animal may not leave the area) up to 620 – 2,800 m away (Table 27). The possible avoidance threshold used in this assessment is at the lower threshold bound at which behavioural responses are expected to occur and may be considered as eliciting only a moderate response to the noise without the animal leaving the area, rather than a strong response where an animal may be expected to move out of the area (upper threshold bound). The potential effects specifically to pygmy blue whales and humpback whales in critical habitats near the operational area are discussed in the following sub-sections.



Note: All air gun measures where received levels for a given survey have been averaged in log spaced range bins and presented as the mean value/bin + 95% confidence limit. The black curves are arrays or single air guns of <1000 cui capacity; the red curve is array of 1000–2000 cui; the blue curves 2000–3000 cui and the magenta curves 3000–4000 cui)

Figure 7: Noise Decay Curves for a Number of Different Seismic Airgun Sources in Western and Southern Australian Waters (Source: Dr Rob McCauley, CMST Curtin University, June 2009)

Pygmy Blue Whale

Threats identified under the Conservation Management Plan for the Blue Whale (2015-2025) of relevance to the activity assessed within this EP include noise interference and vessel disturbance (Commonwealth of Australia 2015). Actions under the management plan that aim to address these threats in accordance with the plan's interim objective of demonstrably minimising anthropogenic threats have also been identified. Specifically for the pygmy blue whale these are 'assessing and addressing anthropogenic noise' (very high priority).

On the basis of stakeholder feedback and the underwater sound modelling and assessment of potential for behavioural disturbance of feeding whales, SLB has reviewed the plans for data acquisition within the possible blue whale foraging area. As a result, the majority of the originally planned survey lines within the nominal pygmy blue whale foraging area have now been removed from the survey (see Exclusion Zone in Figure 2). The most southern survey line retained is required to meet survey objectives and will cross a few hundred metres inside the northern-most extent of the pygmy blue possible foraging area boundary. It is recognised that the far northern extent is likely to support lower densities of whales than the main part of the area because it is a nominal boundary based on regional observations. The southernmost sail line would intersect approximately 8.5 km of the nominal feeding area. Further, noise generated on sail lines up to 2.8 km north of this line could affect the behaviour of a small number of blue whales in the feeding BIA. Additional precautionary control measures will be implemented for operation of the seismic source along this line and for the survey lines within the Seasonal Exclusion Zone (extending a minimum of 3 km north of the boundary of the Ningaloo WHA (Figure 2), including restricting acquisition of data within this area to January – February, when pygmy blue whales are not known to frequent this area. It is therefore unlikely that the behaviour of feeding blue whales would be significantly affected by the activity.

Humpback Whale

Noise interference is identified as a threatening process for humpback whales in the recent Conservation Advice for the species (DoE 2015). Underwater noise modelling predicts that there may be some avoidance behaviour for humpback whales within 2.8 km of the seismic source. The important habitats for humpback whale sin the area, are the calf resting area in Exmouth Gulf, used during the southward migration, and the potentially confined migratory pathway for humpback whales migrating past North West Cape.

The closest the seismic vessel will be to the humpback whale calf resting area in Exmouth Gulf is 14.5 km, therefore no disturbance to the resting area BIA is predicted. Further, data acquisition will be limited to January – February in the lower part of the operational area; at which time the humpbacks are not expected to be present. This extends the spatial buffer around the resting area to over 25 km when the calves and nursing mothers are expected to be present (including conservative allowance for uncertainty in actual migration dates).

The potentially confined migratory pathway for humpback whales migrating past North West Cape is also afforded protection by the Seasonal Exclusion Zone extending a minimum of 3 km north of the boundary of the Ningaloo WHA (Figure 2). Restricting data acquisition in this zone to January or February when humpback whales are not known to migrate through the region, will reduce the potential for displacement of migrating whales. SLB has adopted precautionary measures to address some of the inherent uncertainty in using modelling predictions to define impact zone and to provide further reduction of risk of disturbance to migrating whales. In the event of more than three whale instigated shut-downs in 24 hours, the seismic vessel will move into a new area away from whale presence; and increase precaution zones to 3 km low power and 1 km shut-down. It is therefore unlikely that individuals of this species would be exposed to noise levels associated with the activity that will interfere with the ability of migrating whales to enter the gulf rest area and to migrate past North West Cape.

Due to the implementation of this seasonal restriction and more conservative management measures in accordance with EPBC Policy Statement 2.1, SLB predicts that there will be no acoustic impacts on humpback resting areas, or confined migratory pathways; therefore a noise management plan is not required.

Mid Frequency Cetaceans and Dugongs – Behavioural Disturbance

In terms of a behavioural response, levels at which likely avoidance in mid-frequency cetaceans and dugongs could occur are predicted between 285 and 590 m from the source (Table 27). Possible avoidance may occur between 495 and 1,165 m from the source (Table 27). In general, dolphins avoid operating seismic vessels (Stone and Tasker 2006), and in most cases, the avoidance radii for dolphins are small (1 km or less), with some individuals showing no apparent avoidance (Holst et al. 2006; Moulton and Miller 2005; Stone 2003; Stone and Tasker 2006; Weir 2008). The Operational Area is not an important area for coastal dolphin populations (spotted bottlenose and Indo-Pacific humpback dolphins) and there are no important habitats or BIAs (e.g. for feeding, breeding, calving) within it (Section 2.8). It is however possible that individuals could be encountered transiting through the Operational Area. The possible avoidance threshold used in this assessment is at the lower threshold bound at which behavioural responses are expected to occur and may be considered as eliciting a moderate response only to the noise (i.e. without the animal actually leaving the area), rather than a strong behavioural response where an animal may be expected to move out of the area (upper threshold bound). Therefore, strong avoidance responses would only be expected for mid-frequency cetaceans between 285 and 590 m from the source. Underwater noise impacts resulting in behavioural effects in mid-frequency cetaceans are therefore predicted to be localised, short-term and reversible.

High Frequency Cetaceans – Injury, PTS and Behavioural Disturbance

Based on current knowledge of functional hearing in marine mammals, Southall et al. (2007) defined three distinct, functional groups of cetaceans, based on the frequency range at which their hearing is most sensitive: a) low frequency (LF) cetaceans (7 Hz – 22 kHz); b) mid-frequency (MF) cetaceans (150 hertz – 160 kilohertz); c) high frequency (HF) cetaceans (200 Hz to 180 kHz). Of the list above, only the two *Kogia* spp. are classified as high-frequency hearing cetaceans; the beaked whales are all mid-frequency (Southall et al. 2007; see Attachment 4a). *Kogia* spp. are both widely distributed around Australia although there have only been a few sightings of live animals; two sightings of *K. breviceps* and 1 of *K. sima* (SPRAT database 21.7.2016). The DoE has not identified any biologically important areas for either of the *Kogia* spp. in north-west Australian waters (http://www.environment.gov.au/system/files/pages/5d4fea2c-18a0-40c5-a1ad-fcfc91e5852f/files/bia-species-table.xlsx).

The potential injury (PTS) and behavioural avoidance criteria are the same for low-, mid- and high-frequency cetaceans (Southall et al. 2007). This indicates that the levels of disturbance of pygmy and dwarf sperm whales, will be much the same as for the humpback and blue whales. Therefore the minimum 3 km buffer zone conservatively set to minimise disturbance of blue whales and humpback whales can be applied to the two high-frequency sperm whale species and other cetacean species. Both sperm whale species are considered rare and the chances of encountering them during the survey are very low. They inhabit deep outer continental shelf waters and in the region may visit the deep waters of the Exmouth Trough and the Wallaby Saddle (several hundred km south). The Species Report Card for cetaceans, supporting the marine bioregional plan

for the North-west Region (CoA 2012) indicates that sperm whales may occur in areas of upwelling and canyons on the continental shelf.

Given the low rate of encounter in deep offshore waters, the small distance over which behavioural disturbance would be expected (<3 km), the absence of narrow restricted migratory routes, and the existing EPBC Policy Statement 2.1 control measures in place to protect all whales, the level of risk is considered very low. Localised disturbance to a small number sperm whales (including *Physeter* sp.) is considered unlikely to have any effect on the breeding, feeding or migratory success of the whales, and is therefore considered Acceptable.

4.4.2.9 Potential Cumulative Noise Impacts

A number of stakeholders including Fat Marine, Onstrike Charters, Diversity Bluewater Adventures and CCG have raised concerns about cumulative effects of seismic; multiple surveys could potentially increase these risks to sensitive receptors in the region.

Multiple seismic surveys occur within the offshore Northern Carnarvon Basin every year and several organisations monitor potential impacts and risks of cetaceans within the region. For example the BRAHSS project (behaviour response of Australian humpback whales to seismic surveys) is a major research undertaking aimed at understanding how humpback whales respond to seismic surveys and to provide the information that will allow these surveys to be conducted efficiently with minimal impact on whales (BRAHSS 2015). To date no significant impacts have been reported.

During the planned survey window (September 2016 to September 2018), there are likely to be several surveys planned and implemented within the broader region; some overlapping the Operational Area (refer to Table 14). In the event that another vessel is acquiring seismic data, the survey vessel shall not acquire data simultaneously within 40 km of another seismic vessel in order to avoid interference in data collection and consequently to provide a wide buffer between the vessels and avoid cumulative impacts to cetaceans.

Table 27: Summary of Impact Ranges for Low and Mid-Frequency Cetaceans and Dugong for a 3,147 in^3 Airgun Array

Marine Mammal Group	Threshold Description	Threshold Value (dB re 1 μPa^2.s)	Impact Distance Range
Low-frequency Cetaceans (M_{lf})	Injury	198 SEL	18 – 50 m
	TTS-onset / Fleeing	183 SEL	110 – 170 m
	Likely Avoidance	152 SEL	340 – 975 m
	Possible Avoidance	142 SEL	620 – 2,800 m
	EPBC Act Policy Statement 2.1 Threshold [1]	160 SEL	495 – 1,165 m
Mid-frequency Cetaceans (M_{mf}) and Dugong	Injury	198 SEL	18 – 50 m
	TTS-onset / Fleeing	183 SEL	110 – 170 m
	Likely Avoidance	170 SEL	285 – 590 m
	Possible Avoidance	160 SEL	495 – 1,165 m

Note 1: Threshold is 160 dB re 1 µPa2.s for 95% of shots at 1 km

4.4.2.10 Potential Impacts to Dugong

Dugong appear vulnerable to anthropogenic noise, although there is little information available on their auditory systems and hearing sensitivities. They have small eyes and poor eyesight and often live in turbid inshore waters; this suggests little reliance on visual cues (Piggins et al. 1983). Therefore, it is likely, that acoustic cues and vocalisations are important to this

species for communication (Ichikawaet et al. 2011). Manatees are also sirenians and have hearing capabilities between approximately 250 Hz and 80 kHz (Gerstein et al. 1999 and Mann et al. 2005 in BOEM 2014).

Large numbers of dugong have been recorded in the Exmouth Gulf (Prince 1986), but these animals are unlikely to be exposed to noise disturbance during the survey. The impact ranges (based on mid-frequency cetaceans) indicate that injury / PTS-onset would only occur in animals at extremely close ranges to the seismic source; 18 to 45 m from the seismic source in the shallow waters they inhabit. Impact ranges for TTS are also very small and are predicted to occur within 110 to 165 m of the seismic source (Table 27). It is highly unlikely that a dugong would be exposed to these levels as the BIA for dugong breeding, foraging, feeding and nursing for dugongs in Exmouth Gulf and along the Ningaloo Coast, lies 7.9 km from the closest point on the Operational Area boundary. These areas are well beyond the area where permanent or temporary injury would be expected. There is a low likelihood of encountering dugongs in the Operational Area during the survey due to the majority of the Operational Area (>99%) in water depths of >50 m and where habitat suitable for supporting dugong populations (i.e. seagrass) is absent.

4.4.2.11 Potential Impacts to Whale Sharks

Sharks are sensitive to low frequency sounds between 40 and 800 Hz; sensed solely through the particle-motion component of an acoustic field (no sound pressure). However, sharks do not appear to be attracted by continuous signals or higher frequency sounds which presumably they cannot hear (Popper and Løkkeborg 2008). Hearing studies show that elasmobranchs may detect particle motion associated with sound from 50 Hz to 500 Hz (Normandeau Associates 2012). As elasmobranchs (sharks and rays) do not possess swim bladders, and hence internal organs that have a disparity of acoustic impedance between water and gas filled chambers, these fish are not susceptible to physiological trauma associated with high underwater noise levels (McCauley 1994; Normandeau Associates 2012).

Underwater noise modelling predicts behavioural avoidance up to 2.6 km from the seismic source, and the whale shark aggregation / foraging area along the Ningaloo Coast is 8.7 km from the operational area; therefore, no disturbance to whale shark aggregations in this area is predicted. The whale shark offshore foraging area to the north-east and east of the operational area covers a very large expanse of offshore open waters off the northern coastline of Western Australia. The foraging season is known to occur from July to November as whale sharks migrate from the aggregation area off Exmouth to outside of Australian waters. Whale sharks are generally solitary outside of aggregation periods and so it is expected that any disturbance will be limited to effects on individuals transiting through the area. The Seasonal Exclusion Zone where seismic data acquisition will be restricted to January and February (see Figure 2) will add protection to whale sharks aggregating and foraging in the BIA to the west of North West Cape from March to June, and particularly during the peak month of April. Schlumberger will implement control measures described in Table 56 (including application of EPBC Policy Statement 2.1 management measures) to encourage migrating whale sharks to avoid the seismic vessel, such as pre-start-up observation periods, a gradual increase of power (noise levels) of the airguns, and implementation of low power and shut-down measures.

SLB will engage with tourism operators and request sharing of whale shark and whale intelligence on a daily basis. Tourism vessel operators, who agree to participate in the information sharing, will be requested to radio through any aerial observations as they are received. If the survey vessel is heading toward the observed aggregation, the vessel master will send the chase boat ahead to observe and monitor the aggregation. The survey vessel will take all reasonable action to avoid disrupting such aggregation. Adaptive management may include reducing vessel speed, changing course, reducing airgun power, moving to an alternative sail-line, shutting down airguns if necessary (refer to EPS 57). No effects are predicted at a population level for whale sharks and natural aggregations of whale sharks along the Ningaloo Coast, which support the local whale shark watching tourism, are not expected to be affected.

4.4.2.12 Potential Impacts to Marine Turtles

Marine turtles appear to use acoustic cues in perception of their local and distant environment on their long (sometimes thousands of kilometres) migrations between nesting and foraging sites (Swan et al. 1994). Marine turtles can detect sounds below 1,000 Hz (Bartol et al. 1999). Studies using auditory brainstem responses of juvenile green and olive ridley turtles have shown that juvenile turtles have a 100 to 800 Hz bandwidth, with best sensitivity between 600 and 700 Hz, while adults have a bandwidth of 100 to 500 Hz, with the greatest sensitivity between 200 and 400 Hz (Bartol and Ketten 2006). As discussed previously, the sound from seismic operations is primarily low frequency (between 2 to 200 Hz); therefore, there is

some overlap of the frequencies generated by the seismic survey and the audible frequency range of marine turtles (Ridgway et al. 1969).

Most studies looking at the effect of seismic noise on marine turtles have focused on behavioural changes and responses as physiological damages are more difficult to observe in living animals, and no turtle deaths due to seismic noise have been recorded. Studies carried out by Lenhardt (1994) showed that marine turtles increased their movements after seismic noise emissions and did not return to the depth at which they usually rested. Observational studies have also attempted to monitor turtle avoidance of sound during an active seismic survey (Weir 2007; De Ruiter and Doukara 2010). Weir (2007) observed 240 animals during a 10-month seismic survey off the coast of Angola, during which fewer turtles were observed near the seismic source during noise emissions compared to periods when the seismic noise was not being emitted. De Ruiter and Doukara (2010) also observed turtles during active seismic operations and recorded startle responses (rapid dive) to the seismic emissions; 51% of turtles dived at or before their closest point of approach to a seismic source. However, again, these authors could not distinguish the stimulus source of the startle response, as they did not perform a control without the seismic stimulus (DeRuiter and Doukara 2010).

McCauley et al. (2000) conducted controlled experiments on a caged loggerhead turtle and a caged green turtle and observed two responses:

- exposure to noises from seismic sources louder than 155 dB re 1 μPa^2.s (SEL) increased their swimming activity
- exposure to noises louder than 164 dB re 1 μPa^2.s (SEL) resulted in erratic swimming behaviour, possibly indicating the turtles were in an agitated state.

The study by McCauley et al. (2000) estimated that a typical seismic source could affect the behaviour of marine turtles at a distance of about 2 km and that they would probably avoid the source at around 1 km.

Sub-adult and adult turtles may be more likely to be affected by seismic airgun noise than post-hatchling turtles because of the time that the former remain submerged and at depth. Post-hatchling turtles generally reside at or near the sea surface and may be less likely to be injured by the sound field produced by an airgun array during a survey, due to the rapid decay of waterborne seismic signals at the sea surface (Urick 1983). Behavioural changes are expected to only last for the duration of a survey pass with normal behaviour anticipated to resume when the vessel has moved this distance or more away along the seismic sail line.

The waters off the North West Cape and to the east of the Operational Area around Barrow Island are recognised as biologically important areas for inter-nesting turtles; these are centred on major and/or minor rookeries, or the whole Pilbara coast in the case of flatback turtles (Figure 15). The Muiron Islands lies 5.8 km to the southeast of the Operational Area and is an important nesting area (major rookery) for loggerhead turtles, whilst also supporting minor rookeries for flatback, hawksbill and green turtles (Section 2.5). The inter-nesting areas represent the broad area of the sea where female turtle may venture between successive egg-laying events; they are based on greatest distance travelled data from tracking and other observations. The densities of turtles within these areas is typically very low as they spread out from the nesting beaches.

The results of the noise modelling for the 3,147 in^3 array have been used to determine impact ranges for marine turtles for 'mortality' and potential mortal injury and for a strong behavioural avoidance response. Mortality and potential mortal injury are predicted to occur within a small radius of within 190 to 305 m of the seismic source (Table 28). These thresholds are extremely conservative as lethal impacts have been recorded; however, it is unlikely that turtles will remain close enough to the source to be exposed to these sound levels.

Strong avoidance behaviour during the survey is predicted between 405 and 900 m from the seismic source (Table 54). As the nesting beaches on the Muiron Islands are at least 5.8 km to the south-east and therefore at a much greater distance than the threshold for behavioural disturbance, there will be no expected effect on turtles nesting on the Muiron Islands or inter-nesting in the region. Waayers (PhD Thesis 2010) found a peak nesting period of Nov-Jan for loggerheads and Dec-Jan for greens in this region, including the Muiron Islands. Acquisition during January-February period will avoid the first months (November to December) of peak nesting for the turtles. Waayers (2010) also found that a lot of turtle nesting occurs on the eastern sides of the Muiron Islands; shielded from the area of seismic survey by the island mass. The survey in the area closest to the Muiron Islands will be conducted in January-February, at which time some turtles will be nesting on the sandy beaches of the islands and North West Cape. In between nesting events, the female turtles disperse to varying degrees from

the beach and then return to lay again several weeks later. They tend to aggregate near nesting beaches as they choose the right time to emerge and lay and this is also the time when males seek a mate. This leads to various levels of aggregation in the shallow waters adjacent the nesting beaches. DPaW indicates there are a few known mating areas in the Ningaloo Marine Park, where female turtles are seen resting at the water's edge. (https://www.dpaw.wa.gov.au/management/marine/marine-wildlife/66-marine-turtles-in-western-australia?showall=1).

Based on the preceding analysis, the most likely impacts to inter-nesting turtles would be short-term behavioural responses of individuals up to a conservative distance of 1 km from the seismic source. In cases where individual turtles cannot or do not avoid the airgun array, TTS or PTS could occur, but no deaths or life-threatening injuries are expected. Soft-start procedures implemented for whales and whale sharks (Table 30) will gradually ensonify the immediate area and are expected to encourage turtles to move away from the increasing noise. Regardless, Schlumberger recognise the importance of the area for turtles and will implement an additional control measure in the event that turtles are encountered and do not move away from the source.

Conservation atlas buffers were based on early tracking data and reflect nominal inter-nesting areas within which additional controls should be considered to reduce potential impacts to breeding turtles. While this buffer of 20 km is largely true for flatback turtles (up to 60 km inter-nesting range), loggerheads only have an inter-nesting buffer of around 5 km (Hart et al 2010). Hays et al (1999) showed green turtles stayed within 5 km of the beach while inter-nesting. Further, much of the inter-nesting migration is along-shore rather than out to sea. Whittock et al (2014) showed that inter-nesting Pilbara island flatbacks tend to migrate towards the mainland coasts, and that the longest inter-nesting movement from the inshore turtles are alongshore (rather than out to sea). It is likely that a large proportion of the turtles nesting on the Muiron Islands will move away from the survey area towards the mainland coast during inter-nesting. The greater the inter-nesting range, the greater the dispersion of turtles at sea and therefore the lower the density of encounter and the lower the likelihood of disturbance of natural behaviours. Much the same as any vessel activity in the area (tourism operators, fishing, cargo), disturbance will be limited to avoidance response followed by rapid resumption of normal activity.

If a marine turtle is seen within 350 m of the operating acoustic source, a "shot pause" procedure will be implemented. The "shot pause" involves briefly suspending the acoustic source to allow a silent period when the source array is likely to pass over or be parallel to the turtle's position. The intent of the voluntary silent period is to maintain silence of the acoustic source during its closest point of approach to the turtle's predicted location. The seismic source will power-up when the turtle is observed to be >350 m from the source, or has not been seen for 15 minutes.

In general, the seismic survey would not be expected to result in the long-term or permanent displacement of turtles from nesting beaches or nearshore habitats as the majority of the Operational Area (>99%) in water depths of >50 m is outside the recognised BIAs and habitat suitable for foraging turtles is absent.

Table 28: Summary of Impact Ranges for Marine Turtles for a 3,147 in^3 Airgun Array Volume

Threshold Description	Threshold	Impact Distance Range
Mortality and potential mortal injury	>210 dB re 1 μPa SPLpeak	190 - 305 m
Behaviour: strong avoidance	164 dB re 1 μPa^2.s SEL	405 - 890 m

4.4.2.13 Potential Impacts to the Northern subsea Cape Range

The Northern subsea Cape Range sub-sea canyons overlap with the southern area of the operational extending west and north-west outside of the operational area. SLB acknowledges the significance of the Northern subsea Cape Range sub-sea canyon, which directly influences primary productivity associated with the possible blue whale foraging area. The latest GIS data available sourced from Geoscience Australia (Huang & Nichol (2015) has built on previous classification of canyons around the Australian coast and maps the Cape Range Canyons and 'Other Canyons' as shown on Figure 22. Noise will not affect the values of these seabed features.

Due to the change in the Operational Area that now excludes the southern area over the majority of the pygmy blue whale possible foraging area, most of these canyons are now excluded from the Operational Area. Furthermore, SLM will implement a seasonal restriction in data acquisition within the area defined as the Seasonal Exclusion Zone in order to provide protection to values that the KEF supports, such as pygmy blue whales.

4.4.2.14 Protected Area Values and Management Objectives

SLB has undertaken the impact and risk assessment including the development of appropriate control measures in accordance with the management strategies, objectives/actions of the Ningaloo WHA/CMR/MP, Muiron Islands MMA management plans and consistent with Australia's IUCN Principles (Environment Australia 2002). Central to achieving this is SLB's commitment to protecting the environment in line with the SLB corporate QHSE Policy including minimising its impact to the environment and to communicate openly with stakeholders.

Specifically, SLB has adopted controls within this EP to reduce environmental impacts and risks to ALARP and of acceptable levels. This includes a commitment to avoid unacceptable risks within the Ningaloo WHA, by avoiding seismic acquisition or line-turns within the WHA, through the application of a buffer zone (Section 4.4.3). Controls described ensure that the activity will not affect the marine biodiversity of marine protected areas and the key ecological processes and life support systems; the activity is not expected to alter or result in any long term impacts to the natural state of KEFs or Ningaloo WHA.

SLB has also taken into consideration the key values of the protected areas within the Ningaloo WHA including assessments of the impacts and risks as well as controls for:

- Humpback whales, blue whales and numerous other species of whales and dolphins known to occur in the region (Section 4.4.2.8);
- Important breeding and feeding habitats for threatened and migratory fish (Section 4.4.2.7), whale sharks (Section 4.4.2.11), dugongs (Section 4.4.2.10) and turtles (Section 4.4.2.12);
- Whale sharks aggregating annually from March to June (see Section 4.4.3); and
- Significant seafloor features and a continuous connectivity corridor from shallow depths (~15 m) out to deep offshore waters on the abyssal plain (>5,000 m) (see Section 4.4.2.13).

Section 4.3.3 describes controls to manage risks and impacts to other stakeholders including relevant persons using protected areas within the Ningaloo WHA for tourism, recreational, scientific, commercial cultural or any other reasons. SLBs stakeholder consultation is described in Section 3. The SLB consultation strategy encourages open dialogue to facilitate, manage, and where appropriate, work cooperatively with relevant person to manage interactions with their activities (i.e. recreational, commercial and cultural) in the reserves within an equitable and ecologically sustainable framework.

Furthermore, SLB considers that the activity will not impact on the aesthetics or cultural values of the protected areas within Ningaloo WHA or other marine conservation areas. There are no listed cultural heritage properties in the offshore area (Section 2.9) nor has there been any objection to the activities of cultural heritage grounds following consultation with the NWC Aboriginal Corporation (Section 3.3).

4.4.2.15 Potential Impacts to Commercial Fisheries

A series of studies have been undertaken to determine the effects of seismic surveys on fish catches and distribution, primarily in the United States and Europe (e.g. California: Greene 1985, Pearson et al. 1992; Norway: Dalen and Knutsen 1987, Lokkeborg and Soldal 1993; and UK Pickett et al. 1994). While the conclusions from these studies are largely ambiguous, due to the inherently high levels of variability in catch statistics, one study noted that pelagic species appear to disperse, resulting in a decrease in reported catches during the surveys (Dalen and Knutsen 1987).

Engås et al. (1996) and Engås and Løkkeborg (2002) looked at the effects of a seismic exploration on fishing success for haddock (*Melanogrammus aeglefinus*) and Atlantic cod (*Gadus morhua*). They found that, compared to pre-seismic catches, there was a significant decline in the long-line catch rate during and after the seismic study. The catch rate did not return to normal for five days after the end of the seismic study, although evidence of this decline being related solely to the survey is inconclusive. More recently, the same group used sonar to observe the behaviour of blue whiting and Norwegian spring

spawning herring during a seismic operation and observed that fish would dive from the seismic source and not return until after the activity had stopped (Slotte et al. 2004).

La Bella et al. (1996) reported that no apparent changes in trawl catches were found in short-finned squid (*Illex coindetti*) nor in Norway lobster (*Nephrops norvegicus*) the day after a seismic survey using an airgun at a SPL of 210 dB re 1 μPa at 1 m (corresponding to levels of 149 dB re 1 μPa at the animals' location).

A number of studies have examined the potential effects of seismic surveys on catch levels in fisheries targeting benthic crustaceans such as prawns and rock lobster. Andriguetto-Filho et al. (2005) investigated the effect of seismic surveys on prawn fisheries in relatively shallow waters (2 to 15 m) in Camamu Bay, north-western Brazil. Catch rates of various shrimp species were measured before and after use of a four airgun array with a source peak pressure of 196 dB re 1μPa at 1 m. Catch rates were found to be unaffected. Parry and Gason (2006) investigated the effect of seismic airgun discharges on southern rock lobster (*Jasus edwardsii*) via statistical analysis of the coincidence between seismic surveys and changes in commercial catch rates in western Victoria between 1978 and 2004. There was no evidence that catch rates of rock lobsters in western Victoria were affected by seismic surveys in the weeks or years following the surveys.

A study undertaken by the CSIRO and Geoscience Australia (Thomson et al. 2014) examined fisheries catches (10 species of interest) and catch rates for potential effects from 183 seismic surveys undertaken in the Gippsland Basin (Bass Strait). This study found no clear or consistent relationships between seismic surveys and subsequent fisheries catch rates (Thomson et al. 2014).

In addition to impacts on adults of a fishery species, any reduction in spawning or recruitment success may reduce the yield of a species in subsequent years. This can, in turn, contribute to longer-term impacts due to a reduction in spawning stock for the following year. Studies show that effects on fish eggs and larvae populations within survey areas are insignificant, especially when considered with respect to population size and the natural mortality rates for these organisms (see Section 4.4.2.4).

Commercially and recreationally exploited finfish off the North West Cape comprise an array of highly mobile (not site-attached) species that can easily avoid the approaching airgun well before the noise reaches injurious levels. No mortality or serious physiological effects are predicted.

The seismic vessel will not operate in shallow water <30 m within the Operational Area or directly over shallow reefs as the shallowest water depth that the vessel will operate is 30 m (which makes up a very small proportion of the operational area, 1.72 km^2 or <0.004% of the total Operational Area) with the majority of data acquisition in >50 m water depth (35,164 km^2 or >99%). Noise modelling shows that noise levels reaching shallow reefs, for example around the Muiron Islands (5.8 km from the closest edge of the Operational Area) will be below the behavioural avoidance threshold for fish with or without swim bladders (i.e. avoidance is predicted up to 2.8 km from the seismic source).

Localised effects on the catchability of commercially important finfish species in the Operational Area (pelagic or demersal) will be limited to a small radius on the seabed around the location of the airgun. Effects will be temporary as the seismic vessel traverses each survey line, and fish are expected to move away as the airgun array approaches. The fish are expected to resume normal behaviour (and catchability) within days after the survey vessel has passed. There are therefore no predicted effects to commercially or recreationally caught fish species at a population level, or indirectly to their catch rates for commercial fisheries.

4.4.2.16 Potential Impacts to Human Divers

The type of breathing apparatus worn by a diver, i.e. diving helmet (dry ear) or hood (wet ear), is important in determining the noise hazard as human hearing is more sensitive in air than in water (Parvin et al. 1994). This is due to the 'wet' ear effect (water in contact with the head and in the auditory canal, such as SCUBA divers and band-mask divers) versus 'dry' ear effect (wearing diving helmets and the ear is surrounded by air) (Parvin et al. 1994). Studies have shown that there is a reduction in hearing sensitivity underwater for SCUBA divers, with commercial divers wearing helmets considered the 'worst' case group in terms of sensitivity to underwater noise (Parvin et al. 1994; Anthony et. 2010).

Schlumberger has compared the underwater noise modelling results with both thresholds proposed by (Fothergill et al. 2001 and Parvin et al. 2002). Based on these thresholds, divers are predicted to hear underwater noise from the seismic survey at distances 6 km (at 155 dB SPL threshold) to 8 km (at 145 dB SPL threshold) from the source (Table 29).

Due to the recognised uncertainty in using modelled predictions to define areas of impact for receptors, a highly precautionary approach has been taken in the assessment and the more conservative threshold of 145 dB SPL used to base the distance for which there will be minimal expected effects on recreational divers from seismic noise. Therefore it is expected that divers further than 8 km from the seismic source will not be adversely affected by underwater noise from the seismic survey. As a further precautionary measure due to the limited data surrounding effects of noise on recreational diver comfort and enjoyment of the tourism experience, a further 2 km safety buffer is proposed around the active seismic source (i.e. 10 km). Dive charter operators have been advised to avoid diving within the transient 10 km buffer zone around the source (see Section 4.3.3).

Dive sites on the west side of the Muiron Islands (the known dive sites closest to the operational area) are over 5.5 km from the seismic source. It is likely that divers at this site would hear the seismic noise during the time when the vessel is within 8 km of the islands. This will be a temporary interference and dive operators will be advised 48 hours in advance to allow them to plan to visit alternative dive sites, if they want to avoid hearing the seismic noise. Given the vessel will only be present within 10 km of the islands when acquiring the eastern end of the sail lines and sometimes this will be at night and during periods of weather unsuitable for diving at sites exposed to westerly winds (afternoons in summer), potential for interference with divers is low.

Table 29: Predicted long range maximum modelled received levels at various ranges from the centre of the 3147 in^3 source array

Sound Level Metric	Distance		
	5 km	10 km	20 km
SEL (dB re 1μPa^2·s)	126	107	86
SPL peak-peak (dB re 1 μPa)	157	138	117

4.4.3 Control Measures and Measurement of Environmental Performance

Table 30 provides the control measures that SLB will implement during the activity to manage any potential impacts associated with underwater noise from operation of the seismic source. All control measures from Revision 1 of the EP have been assessed, and where Schlumberger considers that the sacrifice (in terms of time, cost and/or effort) is not grossly disproportionate to the environmental benefit gained, then those controls have been adopted for the activity.

4.4.4 Residual Risk

With the implementation of the control measures described in Table 30, the consequence of underwater noise from seismic operations adversely affecting marine receptors is reduced to moderate and unlikely; the residual risk is therefore Medium. In accordance with the definition of a low residual risk within SLB's risk assessment matrix, the risk is therefore considered 'Broadly Acceptable'.

Table 30: Controls Measures and Environmental Performance Outcomes and Standards for Underwater Noise from Operation of the Seismic Source

EPO:			
Control Measure	**EPS**	**MC**	**Responsible**
Seismic airgun array designed to direct sound energy downwards and reduce horizontal spreading; this will reduce horizontal sound propagation and reduce impacts to marine fauna in the water column. Note: this also reduces potential for propagation into State waters	**EPS 28:** Seismic airgun array designed to direct sound energy downwards and reduce horizontal spreading; this will reduce horizontal sound propagation and reduce impacts to marine fauna in the water column.	Sound source modelling report.	Vessel Master
In the event that another vessel is acquiring seismic data in the region, the survey vessel shall not acquire data simultaneously within 40 km of the other seismic vessel in order to avoid cumulative impacts to marine fauna. Note: this avoids cumulative impacts from simultaneous surveys.	**EPS 29:** In the event that another vessel is acquiring seismic data in the region, the survey vessel shall not acquire data simultaneously within 40 km of the other seismic vessel in order to avoid cumulative impacts to marine fauna. Note: this avoids cumulative impacts from the two surveys.	Vessel records show no breach of these requirements.	Vessel Master
Pre-planning search of NOPSEMA approvals data to identify potential for overlap with other seismic surveys	**EPS 30:** All other submitted EP s for seismic surveys in the region will be reviewed to ascertain potential overlap	Documented EP search	SLB Project Manager
EPBC Policy Statement will be implemented for whales and whale sharks.	**EPS 31:** EPBC Policy Statement controls applied in the event of observations of whales and whale sharks.	MFO data sheets / report verify implementation of procedure.	MFO
Seismic vessel operations will adhere to EPBC Policy Statement 2.1 Part A Standard Management Measures for whales and whale sharks:			
Pre-start-up visual observation: visual observations for whales and whale sharks undertaken in the 3 km “observation zone” by MFOs for 30 minutes prior to commencement of soft start procedures.	**EPS 32:** Pre-start-up visual observation: visual observations for whales and whale sharks undertaken in the 3 km “observation zone” by MFOs for 30 minutes prior to commencement of soft start procedures.	MFO data sheets / report verify implementation of procedure.	MFO
Soft start procedures: may only commence if no whales or whale sharks have been sighted within the low power or shutdown zone during the pre-start-up visual observations. Soft start procedures will be used each time the acoustic source is initiated; gradually increasing power over a 30-minute period.	**EPS 33:** Soft start procedures: may only commence if no whales or whale sharks have been sighted within the low power or shutdown zone during the pre-start-up visual observations. Soft start procedures will be used each time the acoustic source is initiated; gradually increasing power over a 30-minute period.	MFO data sheets / report verify implementation of procedure.	MFO
If a whale or whale shark is sighted within the 3 km observation zone during the soft start, an additional trained crew member will be brought onto the bridge to monitor the animals.	**EPS 34:** If a whale or whale shark is sighted within the 3 km observation zone during the soft start, an additional trained crew member will be brought onto the bridge to monitor the animals.	MFO data sheets / report verify implementation of procedure.	MFO

EPO:			
Control Measure	**EPS**	**MC**	**Responsible**
If the whale or whale shark enters the "low power zone" (<2 km) the source will be powered down to the lowest setting; and if it enters the "shut-down zone" (<500 m) the acoustic source will be shut down completely.	**EPS 35**: If the whale or whale shark enters the "low power zone" (<2 km) the source will be powered down to the lowest setting; and if it enters the "shut-down zone" (<500 m) the acoustic source will be shut down completely.	MFO data sheets / report verify implementation of procedure.	MFO
Following a shut-down, soft start procedures will only commence after the whale or whale shark has moved outside the low power zone, or when 30 minutes have elapsed since the last sighting.	**EPS 36:** Following a shut-down, soft start procedures will only commence after the whale or whale shark has moved outside the low power zone, or when 30 minutes have elapsed since the last sighting.	MFO data sheets / report verify implementation of procedure.	MFO
If the array is shut down for any reasons during the survey (including as a result of whale entering the shutdown zone or entering a 'no acquisition zone'), either visual observations for whales will continue until the soft start procedure commences; or pre-start visual observations will apply prior to re-commencement. This is to ensure observations are either continuous or at least occurring for 30 minutes prior to the commencement of the soft start procedure.	**EPS 37:** If the array is shut down for any reasons during the survey (including as a result of whale entering the shutdown zone or entering a 'no acquisition zone'), either visual observations for whales will continue until the soft start procedure commences; or pre-start visual observations will apply prior to re-commencement. This is to ensure observations are either continuous or at least occurring for 30 minutes prior to the commencement of the soft start procedure.	MFO data sheets / report verify implementation of procedure.	MFO
Shut-down or power down the acoustic source to the lowest setting when not collecting data, or undertaking soft start procedures (e.g. during line turns or when moving to another part of the Operational Area).	**EPS 38:** Shut-down or power down the acoustic source to the lowest setting when not collecting data, or undertaking soft start procedures (e.g. during line turns or when moving to another part of the Operational Area).	MFO data sheets / report verify implementation of procedure.	MFO
At night or at other times of low-visibility, start-up of the acoustic source will occur: ▪ providing that there have not been three or more whale or whale shark instigated power-down or shut-down situations during the preceding 24 hour period ▪ if operations were not underway during the preceding 24 hours, the vessel has been in the vicinity (approximately 10 km) of the proposed start-up position for at least two hours (under good visibility conditions) within the preceding 24 hour period, and no whales or whale sharks have been sighted.	**EPS 39:** At night or at other times of low-visibility, start-up of the acoustic source will occur: ▪ providing that there have not been three or more whale or whale shark instigated power-down or shut-down situations during the preceding 24 hour period ▪ if operations were not underway during the preceding 24 hours, the vessel has been in the vicinity (approximately 10 km) of the proposed start-up position for at least two hours (under good visibility conditions) within the preceding 24 hour period, and no whales or whale sharks have been sighted.	MFO data sheets / report verify implementation of procedure.	MFO
The precaution zones for the survey are based on a precautionary approach and will be as follows: ▪ Observation zone: 3+ km horizontal radius from the acoustic source	**EPS 40:** The precaution zones for the survey are based on a precautionary approach and will be as follows: ▪ Observation zone: 3+ km horizontal radius from the acoustic source	MFO data sheets / report verify implementation of procedure.	MFO

EPO:			
Control Measure	**EPS**	**MC**	**Responsible**
▪ Low power zone: 2 km horizontal radius from the acoustic source ▪ Shut-down zone: 500 m horizontal radius from the acoustic source.	▪ Low power zone: 2 km horizontal radius from the acoustic source ▪ Shut-down zone: 500 m horizontal radius from the acoustic source.		
Relevant vessel crew members are inducted in their responsibilities regarding vessel / marine fauna interactions.	**EPS 41**: Relevant vessel crew members are inducted in their responsibilities regarding vessel / marine fauna interactions.	Induction records show attendance by crew with bridge watch duties	MFO
	EPS 42: Reference material will be available onboard all vessels, including a hard copy of EPBC Act Policy Statement 2.1, the Department's Whale and Dolphin sighting report form and the APPEA CD Guide Search Australian Whales and Dolphins and binoculars.	Audit / inspection records.	MFO
Whale sighting will be reported in accordance with Compliance and Sighting Reports requirements.	**EPS 43:** A report on the conduct of the survey, and any whale interactions, will be prepared within two months of survey completion and provided to DotE (details of report in accordance with Section 4.14.2).	Survey report	SLB Project Manager
Seismic vessel operations will adhere to EPBC Policy Statement 2.1 Part B Additional Management Measures for whales and whale sharks:			
At least two trained MFOs will observe whales and whale sharks during all seismic survey activities conducted in daylight hours. Two MFOs will be stationed on an elevated platform on the seismic survey vessel during humpback and pygmy blue whale migration and aggregation periods. An additional MFO will be stationed on the scout vessel (as required) during the whale shark aggregation and migration periods. The third MFO will provide confidence in detecting whale sharks at distance from the seismic vessel as the scout vessel will be able to steam ahead of the seismic vessel and relay observations in order to implement Policy Statement 2.1.	Marine Fauna Observers (MFOs) **EPS 44:** Two trained MFOs will observe whales and whale sharks from the main seismic survey vessel during all seismic survey activities conducted in daylight hours. A third MFO will be stationed on the scout vessel during critical whale shark periods (aggregation March – June; migration: July - November). The third MFO will provide confidence in detecting whale sharks at distance from the seismic vessel as the scout vessel will be able to steam ahead of the seismic vessel and relay observations in order to implement Policy Statement 2.1.	MFO report confirms two MFO present on main vessel and a third present on scout vessel during (Mar-Nov).	MFO / SLB Project Manager
Training of the MFOs will be in accordance with details described in Section 4.14.2 of this EP	**EPS 45**: Training of the MFOs will be in accordance with details described in Section 4.14.2 of this EP.	Training records.	SLB Project Manager
If at any time during the survey there have been three or more whale or whale shark instigated power-down or shut-down situations during the preceding 24 hour period	Adaptive Management	MFO data sheets verify	MFO

EPO:			
Control Measure	**EPS**	**MC**	**Responsible**
the first response of the seismic vessel will be to move away from the current area and continue data acquisition in another area. Seismic vessel operations will implement EPBC Policy Statement 2.1 Part A Standard Management Measures for pre-start visual observations and soft start procedures in the new area.	**EPS 46:** If at any time during the survey there have been three or more whale or whale shark instigated power-down or shut-down situations during the preceding 24 hour period the first response of the seismic vessel will be to move away from the current area and continue data acquisition in another area. Seismic vessel operations will implement EPBC Policy Statement 2.1 Part A Standard Management Measures for pre-start visual observations and soft start procedures in the new area.	implementation of procedure.	
In the event that there have been three or more whale or whale shark instigated power-down or shut-down situations during the preceding 24 hour period and the seismic vessel CANNOT move away from the current area and continue data acquisition in another area, SLB will implement the following additional precautionary control measures: ▪ increased pre-start up visual observation period ▪ Increased precaution zone ▪ Increased shut-down zone.	Adaptive Management **EPS 47:** In the event that there have been three or more whale or whale shark instigated power-down or shut-down situations during the preceding 24 hour period and the seismic vessel CANNOT move away from the current area and continue data acquisition in another area, SLB will implement the following additional precautionary control measures: ▪ Pre-start up visual observation will be increased to 45 minutes. ▪ Increased precaution zone: the low power zone will be increased to 3 km horizontal radius from the acoustic source. ▪ Increased shut-down zone: the shut-down zone will be de increased to 1 km horizontal radius from the acoustic source.	MFO data sheets verify implementation of procedure.	MFO / SLB Project Manager
Seasonal Exclusion Zone will be implemented a minimum distance of 3 km from the northernmost boundary of the Ningaloo WHA (Figure 2) where seismic will only be acquired during periods of low sensitivity for marine megafauna (i.e. January and February).	Seasonal Exclusion Zone **EPS 48:** Seasonal Exclusion Zone will be implemented a distance of a minimum of 3 km from the northernmost boundary of the Ningaloo WHA (Figure 2) where seismic will only be acquired during January - February.	MFO data sheets verify implementation of procedure. Vessel records show no breach of these requirements.	MFO / Vessel Master
The following precautionary control measures will be implemented when the seismic vessel is operating the acoustic source within 3 km of the pygmy blue whale possible foraging area (at any time of year): ▪ Pre-start up visual observation: increased to 45 minutes ▪ Increased precaution zones: observation zone increased to 4 km; low power zone to 3 km and shut-down zone to 1 km.	Adaptive Management **EPS 49:** The following precautionary control measures will be implemented when the seismic vessel is operating the acoustic source within the Seasonal Exclusion Zone (Figure 2) (between January and February): ▪ Pre-start up visual observation: increased to 45 minutes	MFO data sheets verify implementation of procedure.	MFO

EPO:			
Control Measure	**EPS**	**MC**	**Responsible**
	▪ Increased precaution zones: observation zone increased to 4 km; low power zone to 3 km and shut-down zone to 1 km.		
In accordance with the EPBC Act Policy Statement 2.1, SLB will notify DotE in the event 3 consecutive days of no night time operations that have resulted from whale instigated shutdowns.	Adaptive Management **EPS 50:** In accordance with the EPBC Act Policy Statement 2.1, SLB will notify DotE in the event 3 consecutive days of no night time operations that have resulted from whale instigated shutdowns	Consultation record.	SLB Project Manager
Passive Acoustic Monitoring (PAM) will be implemented on the seismic vessel at night and during periods of poor visibility when the acoustic source is operational.	Night-time / Poor Visibility **EPS 51**: Passive Acoustic Monitoring (PAM) will be implemented on the seismic vessel at night and during periods of poor visibility when the acoustic source is operational.	PAM data sheets verify implementation locations.	PAM Operator/ Vessel Master
A trained and experienced PAM operator will be engaged for the duration of the survey.	Night-time / Poor Visibility **EPS 52:** A trained and experienced PAM operator will be engaged for the duration of the survey.	Copy of PAM Operator experience / CV	SLB Project Manager
The PAM system capability will have the capacity to receive vocalization of whales within the frequencies (4Hz – 180kHz +/-3dB).	**EPS 53**: The PAM system capability will have the capacity to receive vocalization of whales within the frequencies (4Hz – 180kHz +/-3dB).	PAM system technical specification meets criteria.	PAM Operator
During daylight hours PAM detections will be validated against MFO observations and ranges in order to determine the error (if any) in PAM detection distances.	Night-time / Poor Visibility **EPS 54:** During daylight hours PAM detections will be validated against MFO observations and ranges in order to determine the error (if any) in PAM detection distances.	PAM / MFOs data sheets verify implementation of procedure	MFO / PAM Operator
PAM will be used to trigger low power and shut-down procedures at night and during periods of poor visibility, irrespective of the outcome of any validation.	Night-time / Poor Visibility **EPS 55:** If PAM records prove reliable in estimating distances, then PAM will be used to trigger low power and shut-down procedures at night and during periods of poor visibility when the whales enter the appropriate precaution zones.	PAM / MFOs data sheets verify implementation of procedure	MFO / PAM Operator

EPO:			
Control Measure	**EPS**	**MC**	**Responsible**
If PAM records are shown to be inaccurate in estimating Idistances, the seismic vessel will power-down in the event of a confirmed detection (comprising 3 or more detection records for an individual whale) and not power-up until 30 minutes has passed without another detection.	Night-time / Poor Visibility **EPS 56:** If PAM records are shown to be inaccurate in estimating distances, the seismic vessel will power-down in the event of a confirmed detection (comprising 3 or more detection records for an individual whale) and not power-up until 30 minutes has passed without detection.	PAM / MFOs data sheets verify implementation of procedure	MFO / PAM Operator
SLB or the seismic Vessel Master will liaise with Exmouth-based tourism operators actively using spotter planes and request notification of sightings of whales, whale sharks and turtle aggregations when seismic survey operations are underway. If advised of a aggregations of whales, whale sharks, or turtles SLB will take action to avoid disturbance of the aggregating fauna.	Spotter Planes **EPS 57:** SLB or the seismic Vessel Master will liaise with Exmouth-based tourism operators (who agree to share information) actively using spotter planes and request notification of whale, whale shark or turtle aggregation presence when seismic survey operations are underway. If the survey vessel is advised of an aggregation and the survey vessel is heading toward the observed aggregation, the vessel master will send the chase boat ahead to observe and monitor the aggregation. The survey vessel will take all reasonable action to avoid disrupting such aggregation by a minimum of 3 km. Adaptive management may include reducing vessel speed, changing course, reducing airgun power, moving to an alternative sail-line	Consultation and Survey records show spotter information was used in assessment of adaptive management responses and appropriate action taken.	Vessel Master / MFO / SLB Project Manager
If a marine turtle is seen within 350 m of the operating acoustic source, a “shot pause” procedure will be implemented. The “shot pause” involves briefly suspending the acoustic source to allow a silent period when the source array is likely to pass over or be parallel to the turtle’s position. The intent of the voluntary silent period is to maintain silence of the acoustic source during its closest point of approach to the turtle’s predicted location. The seismic source will power-up when the turtle is observed to be >350 m from the source, or has not been seen for 15 minutes.	Marine Turtles **EPS 58:** The seismic source will only be discharged if an observed turtle is >350 m from the source, or has not been seen for 15 minutes.	MFO data sheets verify implementation of procedure.	MFO

EPO:			
Control Measure	**EPS**	**MC**	**Responsible**
Seismic data only acquired within the Seasonal Exclusion Zone during periods of low sensitivity for feeding and migrating blue and humpback whales (January - February)	**EPS 59**: Seismic data only acquired within 3 km of the northern boundary of the Ningaloo WHA during January - February.	Vessel logs.	Vessel Master
The seismic vessel or activities will not enter the Ningaloo World Heritage Area (unless in the case of an emergency)	**EPS 60:** The seismic vessel or activities will not enter the Ningaloo World Heritage Area (unless in the case of an emergency).	Vessel records show no breach of these requirements. Incident report prepared for non-compliance.	Vessel Master
SLB will maintain a 500 m buffer from the protected and area boundaries where these are directly adjacent to the Operational Area.	**EPS 61**: With exception of the Gascoyne multiple use zone (the operation area overlaps), SLB will maintain a 500 m buffer between the airguns and the listed protected and significant areas adjacent to the operational area.	Vessel records show no breach of these requirements.	Vessel Master
The seismic survey vessel will not enter into shallow waters <30 m water depth, unless in the event of an emergency.	**EPS 62:** The seismic survey vessel will not enter into shallow waters <30 m water depth, unless in the event of an emergency.	Vessel records show no breach of these requirements.	Vessel Master
Noise reduction controls for engines/ machinery on vessels. Ensuring that vessel engines are properly maintained in accordance with planned maintenance systems (PMS) will eliminate excess noise due to poorly operating (i.e. excessive vibration) engines and vessel machinery.	**EPS 63:** SLB will confirm records maintenance for engines and thrusters are in accordance with vessels Planned Maintenance System (PMS).	PMS database demonstrates the latest maintenance has occurred.	Vessel Master
The Vessel Master will be supplied with all maps and GPS coordinates for exclusion zones that will be implemented during the survey, including details of seasonal	**EPS 64:** The Vessel Master will be supplied with all maps and GPS coordinates for exclusion zones that will be implemented during the survey, including details of	Copies of maps and GPS coordinates provided to Vessel	SLB Project Manager

EPO:			
Control Measure	**EPS**	**MC**	**Responsible**
restrictions.	seasonal restrictions.	Master.	
Helicopters: maintenance of moving parts (rotors).	**EPS 65:** Regular maintenance of helicopter rotors in accordance with the manufacturer's guidelines.	Maintenance records.	
Helicopters: minimise number of helicopter crew transfers.	**EPS 66:** The number of helicopter crew transfers will be the minimum to conduct safe operation of the survey.	Audit / inspection records.	SLB Project Manager
Helicopter flight path to be mapped prior to survey to avoid sensitive migratory seabird habitats during the seabird migration period.	**EPS 67**: Helicopter crew inducted in EP commitments relevant to helicopter operations, including mapping of flight paths to avoid seabird rookeries.	Induction records show attendance by helicopter crew and provided with maps of seabird rookeries.	SLB Project Manager
	EPS 68: Helicopter flight log confirms no deviations from pre-planned flight path and no flights over sensitive migratory seabird habitats during the seabird migration period.	Audit / inspection records.	SLB Project Manager
Avoid overlap with peak migration period for humpback whales near Exmouth in July – September (Jenner and Jenner 2009)	**NEW EPS N1:** SLB will endeavour to commence survey no earlier than November 2016 and to complete all seismic data acquisition prior to July 2017. This will avoid overlap with the critical period for migrating and aggregating humpback whales in the Exmouth area.	MFO records show survey only extends past 30 June 2017 if unforeseen events delay acquisition during the 1 November to 30 June period.	MFO / SLB Project Manager
A second seasonal exclusion zone will run from the southern zone to approximately 50 km north of the southern-most sail-line (boundary of operational area). Acquisition will only occur in December – April in this zone to reduce potential for disturbance to migrating humpback whales and whale sharks.	**NEW EPS N2**: In additional seasonal exclusion area has been established to the north of the southern area. Figure 2 shows the two exclusion areas: ▪ Area 1: Northern area without temporal restrictions. ▪ Area 2: Middle area, Acquisition only during December – April. ▪ Area 3: Southern area, Acquisition only during January – February.	MFO records show acquisition in Area 2 restricted to between 1 December and 30 April MFO records shows acquisition in Area 3 restricted to between 1 January and 28 February	MFO / SLB Project Manager
If survey cannot be completed by July 2017, additional mitigation measures will be implemented; namely increasing the pre-start observation period, extending the observation zone, extending the low power zone and extending the shutdown zone;	NEW EPS N3: During the peak humpback whale migration period (July – September), SLB will implement the following additional precautionary control	MFO records show additional mitigation measures implemented if survey extends	MFO / SLB Project Manager

EPO:			
Control Measure	**EPS**	**MC**	**Responsible**
during the peak humpback whale migration period (July – September) This is consistent with EPBC Policy Statement 2.1 Part B.6.	measures: ▪ Pre-start up visual observation will be increased to 45 minutes ▪ Increased observation zone: the observation zone will extended to 4 km horizontal radius from the acoustic source ▪ Increased precaution zone: the low power zone will be increased to 3 km horizontal radius from the acoustic source ▪ Increased shut-down zone: the shut-down zone will be de increased to 1 km horizontal radius from the acoustic source.	past 30 June	
Increase sensitivity of adaptive management triggers for blue whales during blue whale migration periods; namely increasing pre-start observation time, observation zone, low power zone and shutdown zone.	**NEW EPS N4**: During blue whale migration periods (March-June and September-December), SLB will implement the following additional precautionary control measures: ▪ Pre-start up visual observation will be increased to 45 minutes ▪ Observation zone will be increased to 4 km ▪ Increased precaution zone: the low power zone will be increased to 3 km horizontal radius from the acoustic source ▪ Increased shut-down zone: the shut-down zone will be de increased to 1 km horizontal radius from the acoustic source.	MFO records show compliance with extended spatial buffer between 1 March and 30 June, and between 1 September and 31 December.	MFO / SLB Project Manager
Consider use of 'e-source' array if available and able to achieve survey objectives.	**NEW EPS N5**: SLB will investigate the availability and suitability of e-source acoustic source equipment, and if appropriate implement during the survey.	Documentation of assessment of acoustic e-source technology and rationale for implementation or otherwise	SLB Project Manager
Relocate vessel after a shutdown, if greater than 20 whales in observation zone during the pre-start observation, but not close enough to prevent soft start commencing (outside low power zone).	**NEW EPS N6**: If greater than 20 whales observed during the pre-start observation period, vessel will relocate to another line, rather than commence soft-start procedure.	MFO Records for pre-start observations and responses documented if > 20 whales observed.	MFO / SLB Project Manager
SLB will investigate the technical applicability of in-streamer hydrophones to verify the power output of the sound source. Should this prove to be technically robust (without significant modification / upgrade of existing technology), it will be used for	**NEW EPS N7:** SLB will investigate the technical applicability of in-streamer hydrophones to verify the power output of the sound source.	Documentation of assessment of streamer technology for sound source verification and rationale for implementation or	SLB Project Manager

EPO:			
Control Measure	**EPS**	**MC**	**Responsible**
adaptive management to continue to demonstrate ALARP and Acceptability.		otherwise	
	NEW EPS N8: Should streamer technology prove effective for measuring acoustic power levels from source array, SLB will compare measure levels with modelled levels. If modelled level under-estimate potential impacts, the buffer distances will be increased to the conservative distances set in New EPS N4 until such time as the impact assessment can be re-run and an alternative, technically defensible position be reached.	MFO Report confirms appropriate adaptive management enacted following sound source verification study.	

4.5 Routine Permissible Waste Discharges

4.5.1 Description of Source of Impact

Sewage, grey water and putrescible waste will be discharged routinely from the seismic survey vessels and support vessels during the survey. Sewage can contain nutrients such as phosphorus and nitrogen; and greywater can contain detergents, chemicals and suspended solids, food waste, coliform bacteria and some medical waste. Discharges to marine environment may affect local water quality and pelagic fauna.

The seismic survey vessel has a maximum vessel sewage discharge capacity of 15 m^3 and the supply vessel a capacity of 1.1 m^3 (Section 1.1). However, actual volumes of sewage and greywater generated and discharged during the MSS will be much lower; in proportion with the number of persons onboard the vessel. For example, the proposed seismic survey vessel can accommodate up to 70 persons; therefore, assuming full capacity and based on a generation rate of 35 L per person per day of sewage/ greywater, ~2.5 m^3 of sewage/ greywater may be generated per day for a vessel of this size, and ~0.5 m^3 for the supply vessel with 14 people. Note that for these activities, there is no risk that the POB shall exceed the maximum carrying capacity of the vessels sewage treatment plant.

Putrescible waste will be generated at a rate of approximately 1 L per person per day; up to 70 L of putrescible water per day for the seismic survey vessel and 14 L for the supply vessel.

Deck drainage of rain and wash-down water may contain small amounts of detergents, residual hydrocarbons and chemicals spilt on the deck floor. The effects of accidental hydrocarbon discharges are described in Section 4.11.

Bilge water consists of deck drainage and machinery space water that has been directed to a bilge water tank.

4.5.2 Known and Potential Impacts to Environmental Receptors

The known and potential environmental impacts from routine operational discharges are:

- temporary localised decline in water quality in the immediate vicinity of the discharge
- localised increase in biological oxygen demand (BOD)
- localised increase in turbidity of surrounding waters
- attraction of scavengers and predators
- temporary toxicity to local marine flora and fauna (bilge water discharges).

4.5.2.1 Potential Impacts to Water Quality

Sewage discharge studies in the marine environment (Friligos 1985, Parnell 2003, Costello & Read 1994) have shown that reduction in water quality occurs in surface waters (<5 m) but that uptake of nutrients and dilution in the surrounding waters is rapid (within hours). Discharge of sewage, greywater and putrescible wastes can also result in a localised increase in turbidity, temporarily decreasing light availability in the surface waters.

Given the small volumes of sewage, greywater and putrescible wastes to be discharged from the vessels, and the rapid dispersion and dilution of these discharges in offshore waters, the discharge is expected to have little or no effect on productivity (e.g. bacteria and phytoplankton growth) or reduced oxygen demand.

During normal operating conditions, the concentrations of any oil and grease residues in deck drainage and bilge water will be very low and with the rapid dilution and assimilative capacity of the offshore marine environment, the potential for toxicity from hydrocarbon residues is considered low. Bilge water will be treated before discharge and the low concentrations of hydrocarbons discharged would be rapidly assimilated in the surface waters.

4.5.2.2 Potential Impacts to Marine Habitats and Communities

Some fish and seabirds may be attracted to these discharges either directly in response to increased food availability, or indirectly as a result of prey species being attracted to the vessel.

Given the small quantities, intermittent nature of discharge and rapid consumption and dilution of the waste, any attraction is likely to be insignificant and is not expected to result in adverse impacts at an ecosystem or local population level.

No toxic effects on plankton or higher trophic levels would be expected due to the low volumes and concentrations of contaminants and the rapid dilution and dispersion of the discharge.

4.5.3 Control Measures and Measurement of Environmental Performance

Table 31 provides the control measures that SLB will implement during the activity to manage any potential impacts associated with routine permissible waste discharges. All control measures from Revision 1 of the EP have been assessed, and where Schlumberger considers that the sacrifice (in terms of time, cost and/or effort) is not grossly disproportionate to the environmental benefit gained, then those controls have been adopted for the activity.

4.5.4 Residual Risk

With the implementation of the control measures described in Table 31 above, the consequence of routine permissible waste discharges interacting with environmental receptors is reduced to slight and unlikely and the residual risk is Low. In accordance with the definition of a low residual risk within SLB's risk assessment matrix, the risk is therefore considered 'Acceptable'.

Table 31: Controls Measures and Environmental Performance Outcomes and Standards for Routine Permissible Waste Discharges

EPO: Meet legislated discharge requirements for permissible discharges.			
Control Measure	**EPS**	**MC**	**Responsible**
In compliance with Marine Order (MO) 96 (Sewage), a sewage treatment system is used prior to discharge of sewage; and discharge is only permitted in certain areas to minimise impacts to water quality and prevent impacts to sensitive marine fauna and flora.	**EPS 69:** Sewage can be discharged if comminuted and disinfected using an approved system (as per MO 96), and is discharged at a moderate rate while travelling at a speed not less than 4 knots, at a distance no less than 3 nautical miles from the 'territorial sea baseline' (charted coastline).	Discharge logs.	Vessel Master
	EPS 70: As per MO 96 (Sewage), if sewage is not comminuted or disinfected it must be discharged at a moderate rate while travelling at a speed not less than 4 knots, at a distance of no less than 12 nautical miles from the 'territorial sea baseline'.	Discharge logs.	Vessel Master
	EPS 71: As per MO 96 (Sewage) - an International Sewage Pollution Prevention Certificate (ISPP) is required for any vessel of 400 gross tonnage and above, and any vessel certified to carry more than 15 persons.	International Sewage Prevention (ISPP) Certificate is valid.	Vessel Master
	EPS 72: As per MO96 (Sewage) within 12 nautical miles from the territorial sea baseline, if the sewage is not comminuted or disinfected using an approved system, the sewage will be stored in a holding tanks and either transferred ashore for appropriate treatment or discharged > 12 nautical miles from the territorial sea baseline.	Waste transfer certificate issued by licensed facility of carrier for onshore transfers. Discharge logs.	Vessel Master
In compliance with Marine Order 95 (Garbage), putrescible waste discharge to sea will only be undertaken if food waste is ground up or discharged in offshore waters.	**EPS 73**: As per MO 95 (garbage) - food waste can only be discharged to sea if ground or comminuted, to 25 mm or less and discharged when greater than 3 nautical miles from the 'territorial sea baseline'.	Visual inspection records confirm that macerator is functional and in use. Discharge logs.	Vessel Master
	EPS 74: As per MO 95 (garbage) - if food is not ground or comminuted to 25 mm or less it must be discharged greater than 12 nautical miles from the territorial sea baseline while the vessel is underway.	Vessel audit or inspection. Discharge logs.	Vessel Master
Vessels use an oily water treatment system prior to discharge of contaminated water in order to reduce potential impacts to marine fauna.	**EPS 75:** As per the Protection of the Sea (Prevention of Pollution from Ships) Act 1983, prior to any oily water being discharged to sea, it will be processed through oil filtering equipment, will not exceed 15 ppm oil content and will be discharged while the vessel is underway.	Vessel audit or inspection records confirm (i.e. vessel is within survey and equipment is operational). Discharge logs.	Vessel Master

EPO: Meet legislated discharge requirements for permissible discharges.			
Control Measure	**EPS**	**MC**	**Responsible**
	EPS 76: As per MO 91 (Oil) - vessels shall have oil filtering equipment of a design approved by Administration.	Vessel audit or inspection	Vessel Master
	EPS 77: As per MO 91 (Oil) - an International Oil Pollution Prevention (IOPP) Certificate is required for any vessel of 400 gross tonnage and above.	IOPP Certificate is valid	Vessel Master
Secondary containment measures are used to prevent hydrocarbon chemical spills	**EPS 78**:Hydrocarbon and chemical storage areas are fully bunded and drain to the bilge water tank	Vessel audit or inspection of bunds	Vessel Master

4.6 Introduction and Establishment of Invasive Marine Species

4.6.1 Description of Source of Risk

Invasive Marine Species (IMS) are marine plants or animals that have been introduced into a region beyond their natural range and have the ability to survive, reproduce and establish founder populations. Marine species have limited tolerances to environmental variables such as water temperature and can have specific habitat requirements (e.g. shallow water hard substrates). Therefore, not all marine species introduced into an area will thrive and establish themselves as a pest. Species of concern are those that are not native to the region; are likely to survive and establish in the region; and are able to be spread by human mediated or natural means.

During the survey, the vessels will ballast and de-ballast to improve stability, balance vessel stresses and adjust vessel draft, list and trim with regard to weight of equipment and fuel, potable water etc. onboard. The discharged ballast water could contain IMS propagules.

IMS may also be translocated through biofouling on a vessel's hull or other external niches (e.g. propulsion units, steering gear and thruster tunnels); biofouling of vessel internal niches (e.g. sea chests, strainers, seawater pipe work, anchor cable lockers and bilge spaces); and biofouling on equipment that routinely becomes immersed in water (e.g. seismic steamers).

Following their establishment, eradication of IMS populations is often impossible; limiting management options to ongoing control or impact minimisation. For this reason increased management requirements have been implemented in recent years by Commonwealth and State regulatory agencies with further legislation currently under development. Reducing the risk of IMS introduction and establishment represents by far the most effective and cost-efficient means of managing the threat of IMS.

4.6.2 Known and Potential Risks to Environmental Receptors

The known and potential risks to environmental receptors from the introduction of IMS include:

- Predation or displacement of native species
- Nuisance biofouling
- Indirect impacts to commercial fisheries and tourism through loss of native species and reduction in biodiversity.

4.6.2.1 Potential Risks to Marine Habitats and Communities

In the unlikely event that a species is introduced and it survives in the new environment, it has the potential to colonise a new region and establish a new population. Over time the population may increase and the species become established in the area. This can cause a range of ecological effects, including increased competition with native species and loss of biodiversity.

The probability of successful establishment of IMS is dependent on a number of factors including survival of the propagules during their transfer to the area, the suitability of the environmental conditions at the recipient site (water temperature, salinity, depth, habitat types, competitors, and predators), the survival of the propagules to reproductive state and the continued success of the introduced population which will compete with native biota.

The potential consequences to marine habitats and communities of IMS being present in ballast water/ biofouling and becoming established are major: with impacts likely to be localised but expected to be long-term due to the difficulties in eradicating IMS.

4.6.2.2 Potential Risks to Commercial Fisheries and Tourism

Commercial fisheries and tourism in the region relies upon the presence of native species. The introduction of IMS could result in competition with native species, and potential loss of biodiversity. This could lead to a decline in potentially available catch for commercial fishing operations, and a reduction in tourism potential as the targeted species became rarer and less prevalent in the area.

The consequence to commercial fishers and tourism of IMS being present in ballast water/ biofouling and becoming established are minor: any impacts realised will likely be short-lived, due to the adaptability of the associated industries and the variety of target species present (for both commercial fishing and tourism purposes).

4.6.3 Control Measures and Measurement of Environmental Performance

Table 32 provides the control measures that SLB will implement during the activity to manage any potential risks associated with IMS. All control measures from Revision 1 of the EP have been assessed, and where Schlumberger considers that the sacrifice (in terms of time, cost and/or effort) is not grossly disproportionate to the environmental benefit gained, then those controls have been adopted for the activity.

Note: The Quarantine Act is to be replaced by the new *Biosecurity Act 2015* from 16 June 2016. Until commencement of the new legislation, the *Quarantine Act 1908* remains the primary biosecurity legislation in Australia.

4.6.4 Residual Risk

With the implementation of the control measures described in Table 32 above, the likelihood of an impact occurring is lowered to highly unlikely, however the worst-case consequences associated with IMS remain major. As such, the residual risk for IMS Management during the activity remains Medium. In accordance with the definition of residual risk within SLB's risk assessment matrix, the risk is considered 'Broadly Acceptable'.

Table 32: Control Measures and Environmental Performance Outcomes and Standards for IMS Management

EPO: Avoid introducing marine pests to Australian waters.			
Control Measure	**EPS**	**MC**	**Responsible**
Prevent vessels from entering Australian waters with ballast water taken from a foreign port that may contain IMS	**EPS 79:** In accordance with the Quarantine Act 1908 - all vessels have AQIS clearance to enter Australian waters in accordance with the Australian Ballast Water Management Requirements (Department of Agriculture 2011).	Quarantine pre-arrival report (QPAR) accepted by Department of Agriculture.	Vessel Master
Activities are managed in accordance with the Quarantine Act 1908. In particular - Ballast water discharges from the vessel must comply with the requirements of the Australian Ballast Water Management Requirements.	**EPS 80:** No discharge of high-risk ballast water within Australian territorial seas (within 12 nautical miles of WA coastline) including any ports.	BWMS forms shows that no high risk ballast water was discharged within Australian territorial seas.	Vessel Master
	EPS 81: Completion of Department of Agriculture Ballast Water Management Summary (BWMS) forms for any ballast water discharge in Australian waters.		
	EPS 82: Whilst in Australian waters, the seismic survey vessel must operate in accordance with the conditions detailed in the "Approval to Berth" issued by AQIS when the vessel entered Australian waters and submitted a QPAR.	Vessel QPAR report	Vessel Master
Anti-fouling systems are maintained	**EPS 83:** Vessel anti-fouling systems are maintained in compliance with International Convention on the Control of Harmful Anti-fouling Systems on Ships.	Current International Anti-fouling System Certificate is provided	Vessel Master
Ballast Water Management Plans in place for each vessel which complies with International standards	**EPS 84:** The Ballast Water Management Plans for each vessel must comply with Regulation B-1 of the International Convention for the Control and Management of Ship's Ballast Water and Sediments 2004	Ballast Water Management Plan for each vessel is checked to comply with Regulation B-1.	Vessel Master
Ballast water exchanges and biofouling risk managed in accordance with acceptable risk assessment, such that risk of IMS introduction is assessed as low.	**EPS 85:** Application of AQIS guideline that ballast exchanges are conducted as far as possible away from shore and in water at least 200 m deep.	BWMS form indicates location of ballast water exchange.	Vessel Master
	EPS 86: SLB will implement DoF's biofouling risks assessment tool (http://vesselcheck.fish.wa.gov.au) and complete necessary actions so that any activity related to vessels is LOW/ ACCEPTABLE risk rating.	Risk assessment for vessel prior to entering Australian waters and corrective actions report (if required).	Vessel Master

EPO: Avoid introducing marine pests to Australian waters.			
Control Measure	**EPS**	**MC**	**Responsible**
Cleaning of equipment prior to use in an area that does not present a risk of IMS introduction.	**EPS 87:** All infield equipment (e.g. streamers) will be cleaned between survey operations, which do not occur in adjacent bioregion waters so the equipment does not present a risk of IMS introduction.	Report or evidence that all field equipment was cleaned.	Vessel Master
Reporting marine pests	**EPS 88:** SLB will report IMS as described in Section 4.14.1.	Incident report/ consultation record.	Vessel Master

4.7 Artificial Light Generation

4.7.1 Description of Source of Impact

Light generation on board the vessel will include a range of light sources, such as internal lighting, deck lighting and navigational lights. Vessels are required to show lights when operating at night to indicate their position and seismic vessels must indicate their limited ability to manoeuvre. The deck crew will require adequate lighting for safe operations.

4.7.2 Known and Potential Impacts to Environmental Receptors

Known and potential environmental impacts resulting from artificial lighting include:

- disorientation, attraction or repulsion of sensitive marine fauna (particularly turtle hatchlings and juvenile seabirds)
- disruption to natural behavioural patterns and cycles, e.g. nocturnal foraging.

4.7.2.1 Potential Impact to Protected Species

Artificial lighting has the potential to affect the behaviour of marine fauna, especially marine turtle hatchlings (Limpus 1971; Salmon and Wyneken 1994; Limpus 2007; 2008a; 2008b; 2009). Offshore bright lights have the potential to attract post-emergent turtle hatchlings, which orientate towards light sources close to the horizon when moving from the nest to the sea (Witherington and Martin 2003). This is a particular issue when orientating from the beach, as once in the surf zone turtle hatchlings are believed to be less influenced by light and navigate using sea-wave and other cues (Witherington and Martin 2003).

Loggerhead, green, flatback and hawksbill turtles may nest on the Muiron Islands during the survey period; with the peak hatching season for these species being in January to April (EPA 2010). Based on the *Environmental Assessment Guideline No. 5 Protecting Marine Turtles from Light Impacts* (EPA 2010), artificial lighting greater than 1.5 km from turtle nesting beaches is less likely to have a significant influence on the sea-finding ability of emerging hatchlings. However, the nearest nesting beaches are 5.8 km (Muiron Islands), 13.3 km (NWC) and 37.5 km (Barrow Island) away from the Operational Area and outside the zone of influence of the vessel lighting.

Given the distance from the closest island/ coastal location, and the offshore nature of the survey parallel to nesting areas meaning that any light generated will likely orientate hatchlings towards the surf-zone, the potential for light generation to impact marine turtles is slight.

Seabirds can be attracted to bright light (Marquenie et al. 2008, Wiese et al. 2001, Surman 2002), which could result in injury if individuals collide with lit infrastructure. Zooplankton and fish are also attracted to bright light (Meekan et al. 2001, Milicich et al. 1992, Lindquist et al. 2005, Shaw et al. 2002), which could affect prey availability for seabirds and other marine fauna. As the vessel will be continuously moving (Section 1), albeit at a slow speed, the effects of light generation will be less than that for a stationary source such as an FPSO, platform or a drill rig, therefore impacts are likely to be restricted to behavioural chances by a small number of fish and birds in the immediate vicinity of the vessel.

4.7.3 Control Measures and Measurement of Environmental Performance

Table 33 provides the control measures that SLB will implement during the activity to manage any potential risks associated with light generation. As part of the ongoing process of reducing risks to ALARP, additional control measures have been provided to those previously presented in Revision 1 of this EP. All control measures from Revision 1 of the EP have been assessed, and where Schlumberger considers that the sacrifice (in terms of time, cost and/or effort) is not grossly disproportionate to the environmental benefit gained, then those controls have been adopted for the activity.

4.7.4 Residual Risk

With the implementation of control measures described in above, the likelihood of artificial light generation adversely affecting marine fauna receptors is unlikely and the consequence is reduced to slight, with the residual risk considered as Low. In accordance with SLB's risk assessment matrix, the risk is therefore considered 'Acceptable'.

Table 33: Control Measures and Environmental Performance Outcomes and Standards for Light Generation

EPO: Minimise potential for adverse impacts on light sensitive marine fauna			
Control Measure	**EPS**	**MC**	**Responsible**
Minimise artificial light generation to that required for safe operations.	**EPS 89**: Non-essential lighting will be switched off when not in use.	Vessel audit or inspection. Crew inductions	Vessel master
	EPS 90: External lighting will be directed onto the deck, reducing light spill to the environment.	Vessel audit or inspection.	Vessel master
In accordance with the Environmental Assessment Guideline No. 5. Protecting Marine Turtles from Light Impacts (EPA 2010), a darkness zone of at least 1.5 km will be maintained around significant beach rookeries (Muiron Islands).	**EPS 91**: A darkness zone (i.e. a zone where artificial light is not visible to nesting or hatchling turtles) will be maintained within 1.5 km of rookeries on the Muiron Islands.	Vessel audit or inspection verifies vessel does not approach within 1.5 km of Muiron Islands during the hours of darkness.	Vessel master

4.8 Atmospheric Emissions

4.8.1 Description of Source of Impact

The combustion of fuel (marine diesel) and incineration of waste during the MSS will result in emissions of greenhouse gases (GHG), such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), along with non-GHG such as sulfur oxides (SO_x) and nitrogen oxides (NO_x).

Vessels may have ozone depleting substances (ODS) in closed loop system such as rechargeable refrigeration systems.

4.8.2 Known and Potential Impacts to Environmental Receptors

4.8.2.1 Potential Impacts to Air Quality

The known and potential environmental impact from atmospheric emissions is a minor deterioration of local and regional air quality due to emission of pollutants. The quantities of gaseous emissions will be localised and are relatively small (average combustion of fuel will be 27 m^3 per day, which will quickly dissipate into the surrounding atmosphere with no measurable increase in air pollutant concentrations. Given the constant movement of the vessel, emissions from the combustion of fuel on board the vessels will not affect sensitive receptors in the vicinity of the Operational Area.

4.8.3 Control Measures and Measures of Environmental Performance

Table 34 provides the control measures that SLB will implement during the activity to manage any potential risks associated with atmospheric emissions. All control measures from Revision 1 of the EP have been assessed, and where Schlumberger considers that the sacrifice (in terms of time, cost and/or effort) is not grossly disproportionate to the environmental benefit gained, then those controls have been adopted for the activity.

4.8.4 Residual Risk

With the implementation of control measures described in Table 34 above, the likelihood of a measurable impact on local air quality is remote and the potential consequence is slight. In accordance with SLB's risk assessment matrix, the residual risk is rated as Low, and is therefore considered 'Acceptable'.

Table 34: Control Measures and Environmental Performance Outcomes and Standards for Atmospheric Emissions

EPO: Combustion engines meet performance standards to avoid prohibited atmospheric emissions			
Control Measure	**EPS**	**MC**	**Responsible**
Compliance with Marine Order 97 (Air Pollution): ▪ Vessels >400 tonnes require a certificate to demonstrate that they comply with the requirement to prevent unnecessary air pollution. ▪ The vessel engines do not emit excess NOx emissions. ▪ Incinerators used are of an approved standard and it is operated correctly. ▪ Vessels must comply with a plan for energy efficiency. ▪ Vessels shall not emit excess sulphur emissions. ▪ Noxious and toxic substances shall not be emitted through combustion of illegal substances. ▪ Ozone depleting substances shall not be deliberately released.	**EPS 92**: As per MO 97 (Air Pollution) - an International Air Pollution Prevention Certificate (IAPP) held by every ship of 400 gross tonnage and above.	IAPP certificate	Vessel Master
	EPS 93: As per MO 97 (Air Pollution) - vessel engines (by class) meet prescribed NOx emission levels.	Vessel audit or inspection.	Vessel Master
	EPS 94: As per MO 97 (Air Pollution) - incinerators shall be an IMO type approved complying with MARPOL and IMO requirements	Vessel audit or inspection	Vessel Master
	EPS 95: As per MO 97 (Air Pollution) - every vessel of 400 gross tonnage and above shall comply with a Ship Energy Efficiency Management Plan (SEEMP).	SEEMP	Vessel Master
	EPS 96: As per MO 97 (Air Pollution) - the sulphur content of any fuel oil used on-board does not exceed 3.50% m/m.	Bunker note or other evidence	Vessel Master
	EPS 97: As per MO 97 (Air Pollution) - noxious and hazardous substances are not incinerated.	Incineration log	Vessel Master
	EPS 98: As per MO 97 (Air Pollution) – Ozone Depleting Substances are not deliberately released.	ODS Record Book	Vessel Master
Compliance with Protection of the Sea (Prevention of Pollution from Ships) Act 1983: ▪ A record of ozone depleting substances shall be kept onboard the vessel.	**EPS 99**: As per the Protection of the Sea (Prevention of Pollution from Ships) Act 1983, an Ozone Depleting Substances Record Book is maintained, if the vessel has a rechargeable system that contains ozone-depleting substances.	ODS Record Book	Vessel Master
Vessels do not use HFO	**EPS 100**: MGO is the primary fuel for vessel use (no HFO powered vessels).	Bunker notes.	Vessel Master
MGO use documented during survey	**EPS 101**: Details of fuel oil (MGO) delivered to and used on the vessel shall be recorded by means of bunkering delivery note that shall contain the information prescribed in MO 97 (Air Pollution).	Bunker note.	Vessel Master

4.9 Physical Presence: Collision or Entanglement with Marine Fauna

4.9.1 Description of Source of Risk

During the activity, the survey and support vessels working within the operational area will present a potential physical hazard (risk of collision) to marine fauna such as whales, dolphins, whale sharks and turtles that may be swimming across the sail-lines at the sea surface.

In additional to vessel movement, helicopters will be transiting between the survey vessel and land, and could pose a potential risk to avifauna, especially when flying over key bird roosting areas.

The end of each streamer will be marked with a tail buoy, which may pose a risk of entanglement with marine fauna, specifically marine turtles.

4.9.2 Known and Potential Risks to Environmental Receptors

The known and potential environmental impacts to marine fauna from the movement of vessels and deployment of seismic equipment within the Operational Area include:

- vessel collision with marine fauna such as cetaceans, whale sharks and turtles at the sea surface
- equipment entanglement with marine fauna such as cetaceans, whale sharks and turtles
- helicopter collision with avifauna
- disturbance leading to behavioural changes or displacement of fauna.

4.9.2.1 Potential Risks to Cetaceans

The vulnerability of cetaceans to vessel collision varies according to behaviour (e.g. surfacing habits, direction of travel in relation to shipping routes); morphology; the function of preferred habitat (e.g. breeding, resting, feeding) in areas of vessel activity; and aspects of shipping such as vessel type, speed, density and location. Slow moving species that frequently surface in areas that overlap with frequent shipping activity are the most vulnerable (Clapham et al. 1999).

Whales and possibly their calves are more susceptible to vessel collision due to their extended surface times (Laist et al. 2001). The global International Whaling Commission (IWC) vessel strike database identifies 14 strikes recorded in Australian waters from January 2008 to August 2010, although it is likely that not all cetacean strikes are reported to the relevant authority, hence the figure may be higher in reality. Only a minority of the recorded incidents occurred in Western Australia in spite of the large annual migration of humpback whales in coastal waters. On the basis of current information, collision with vessels has been identified as being of “potential concern” for humpback whales (Commonwealth of Australia 2012a).

The likelihood of a vessel-whale collision being lethal is influenced by vessel speed; the greater the speed at impact, the greater the risk of mortality (Laist et al. 2001, Jensen and Silber 2003). Vanderlaan and Taggart (2007) found that the chance of lethal injury to a large whale as a result of a vessel strike increases from about 20% at 8.6 knots to 80% at 15 knots.

For the majority of the time, the seismic survey vessel is likely to be moving through the operational area at speeds of less than 5 knots, hence the chance of a vessel-whale collision resulting in lethal outcome at this speed is much reduced. During seismic data acquisition along the sail lines, the seismic survey vessel will be moving at a speed of ~4-5 knots. According to Vanderlaan and Taggart (2007), it is estimated that the risk of a vessel-whale collision resulting in lethal outcome is less than 10% at a speed of 4 knots.

Vessel-whale collisions at this speed are unlikely. Based on the US National Ocean and Atmospheric Administration database (Jensen and Silber 2003) there are only two known instances of collisions when the vessel was travelling at less than 6 knots, both of these were from whale-watching vessels that were deliberately approaching whales.

Considering the cetacean species found in the regional area, it is likely that cetaceans will be encountered during the proposed survey. In the majority of cases, the consequence of an interaction would be realised before collision, i.e. the cetacean will exhibit brief disturbance behaviours, and move away from the vessel and streamers, making the impact

consequence slight and the inherent risk medium. In the highly unlikely event that a vessel-whale collision occurs, the consequence to an individual could be fatal in a worst-case (moderate rating), and inherent risk would be Medium.

4.9.2.2 Potential Risks to Whale Sharks

Whale sharks spend a significant amount of their time close to the surface of the water (DEH 2005a; Norman 1999) and are therefore vulnerable to vessel strike. There is evidence of whale sharks being hit by vessels (DEH 2005a; Norman 1999).

The Operational Area lies outside the aggregation / foraging ground BIA, where whale sharks are known to aggregate in large numbers between March and June. The southern-most sail lines (~ 10 km north of the aggregation/feeding BIA) would be acquired outside the whale shark aggregation period so the potential for collisions is reduced. Outside of the aggregation periods, whale sharks are generally solitary and only low numbers would be expected to be present in the operational area. Given the slow speed of seismic vessel during the survey, the risk of vessel strike is considered low. In the unlikely event of vessel strike within an individual animal, it is unlikely to cause lethal injury and there would be no overall effect on the population. The slow-moving seismic survey poses a lower risk of impact than the existing shipping activity in the region.

It is unlikely that the seismic vessel will collide with a whale shark during the proposed survey, and the consequence of a collision would likely be moderate. As such, inherent risk is Medium.

4.9.2.3 Potential Risks to Marine Turtles

Marine turtles on the sea surface or in shallow coastal waters have typically been observed to avoid approaching vessels by moving away from the vessels track (Hazel et al. 2007). While the potential for vessel strikes at various speeds has not been quantified, the success of avoidance behaviour is a factor of the response time available (i.e. visual observation distance/vessel speed) and Hazel et al. (2007) suggests that higher vessel speed is more likely to cause impacts particularly in shallow waters where turtles are abundant.

While vessel speed is a significant factor, vessel draft may also contribute to the risk of vessel strikes; vessels with less draft provide greater clearance distance between the turtle and the vessel. In the event of a collision, the turtle's carapace provides a level of protection from serious injury, although the type and severity of the injuries would be dependent on the force of the collision and structure of the vessel and whether the animal is struck by the hull or propellers.

Tail buoys are attached to the end of seismic multi-component cables and can present an entanglement risk for turtles with the potential for mortalities (Ketos Ecology 2007). This has been an issue particularly for marine seismic surveys off the west coast of Africa. In recent years, geophysical acquisition companies and seismic contractors have been using "turtle guards" – modifications to the tail buoys that minimise the potential for turtle entrapment. More recently, developments in the design of tail buoys have resulted in tail buoys that don't represent a threat of turtle entrapment.

The operational area overlaps inter-nesting areas (BIAs) for flatback, green, hawksbill and loggerhead turtles. It is possible that inter-nesting turtles may be encountered at low densities during the survey; although most turtles remain close to their nesting beach. On the basis of current information, collision with vessels has been identified as "not of concern" for leatherback and flatback turtles, and of "potential concern" for green, hawksbill and loggerhead turtles (Commonwealth of Australia 2012d). This indicates a low inherent likelihood of turtle collisions in the Operational Area.

Given the proximity to inter-nesting areas, it is likely that interactions may occur between turtles and the survey vessel, however mostly impacts would be behavioural. In the highly unlikely event of collision with tail buoys, consequences would be fatal for the individual (moderate), and inherent risk is Medium.

4.9.2.4 Potential Risks to Avifauna

Protected birds listed in the EPBC Protected Matters Search that may occur within the operational area described in Section 2.7. Take-off and landing helicopters on the seismic survey vessel has the potential for bird strikes. Abundance of birds and this risk is likely to be low in offshore waters, however will vary depending on seasons and locality. The risk of helicopter strike with avifauna is highest during take-off and landing activities and if flying low over a roosting area.

The likelihood of helicopter-avifauna collision is highly unlikely, the potential consequence is individual mortality to potentially protected species (rated as moderate). Inherent risk is Medium.

4.9.3 Control Measures and Measurements of Environmental Performance

Table 35 provides the control measures that SLB will implement during the activity to manage any potential risks associated with the potential for collision with marine fauna / entanglement. All control measures from Revision 1 of the EP have been assessed, and where Schlumberger considers that the sacrifice (in terms of time, cost and/or effort) is not grossly disproportionate to the environmental benefit gained, then those controls have been adopted for the activity.

4.9.4 Residual Risk

With the implementation of the control measures described in above, the likelihood of a risk being realised is reduced to remote. The consequence of a vessel collision / equipment entanglement with marine fauna during the activity is reduced to moderate, and the residual risk is Low. In accordance with the definition of a low residual risk within SLB's risk assessment matrix, the risk is therefore considered 'Acceptable'.

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Table 35: Control Measures and Environmental Performance Outcomes and Standards for Vessel Collision or Entanglement with Marine Fauna

EPO: Avoid colliding with or entanglement with protected species.			
Control Measure	**EPS**	**MC**	**Responsible**
Compliance with EPBC Regulations 2000 – Part 8 Division 8.1 (Regulation 8.04): Vessel masters of support vessels will implement precautionary measures to avoid vessel strikes.	**EPS 102:** Vessel Masters (support vessels) will implement a caution zone, where the vessel will not travel at speeds greater than 6 knots within 300 m of a cetacean or whale shark.	Daily reports Marine fauna sightings sheets	Vessel Master
	EPS 103: Vessel Masters (support vessels) will implement an exclusion zone, where the vessel will not approach closer than 100 m from cetaceans or whale sharks (with the exception of animals bow riding).		
Compliance with Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 – Regulation 26: Any incidents of vessel or towed array collision with cetaceans, turtles or whale sharks must be reported as reportable incidents for the activity.	**EPS 104**: Incidents of vessel or towed array collision with cetaceans, turtles or whale sharks will be reported as reportable incidents for the activity.	Documentation meeting reportable incident requirements; and collision incident reporting if involving a cetacean of whale shark.	Vessel Master
Turtle exclusion device implemented on tail buoys.	**EPS 105**: SLB will implement a turtle exclusion device fitted to each tail buoy.	Equipment inventory shows turtle exclusion devices installed.	Vessel Party Chief
Helicopter flights to avoid key bird nesting/ aggregation areas	**EPS 106**: Helicopter operations will be limited to the most direct routes to vessels (as determined by pilot based on flying conditions/safety).	Flight log from contractor.	Helicopter Landing Officer (HLO)
	EPS 107: The helicopter flight route is not deviated from for the purpose of sightseeing.		
	EPS 108: Helicopters are operated such that safe operating altitude (as dictated by weather, flight paths, pilot judgement etc.) over key bird areas (inshore islands) is maintained to avoid collision with startled birds.		
Vessel master and crew are aware of risk.	**EPS 109**: All seismic survey vessel and support vessel personnel will undertake a survey induction, which outlines the key requirements of EPS 102, EPS 103 and EPS 104.	Induction material and records of attendance.	Vessel Master

4.10 Seabed Disturbance: Loss of Equipment

4.10.1 Description of Source of Risk

During normal operations, the survey vessel will tow 12 seismic streamers with a maximum length of 8 km, at approximately 8 to 9 km/hr. The streamers are buoyed to carefully control their tow depth relative to each other, the source and the seabed; any loss of buoyancy would be quickly remedied to maintain data quality. Should a seismic streamer become detached from the survey vessel or sink and drag on the seabed it has the potential to cause minor physical damage to benthic habitats.

The potential risk of equipment coming in contact with the seabed in shallow waters (<50m) is evaluated based on the following:

- the water depth range across the operational areas is 30 m to 1,500 m
- the tow depth of multi-component cables will be between 15 and 20 m below sea surface dependent on the presence of thermoclines in the area.

No anchoring is planned during the MSS, but may be done in an emergency.

4.10.2 Known and Potential Risks to Environmental Receptors

Direct contact between survey equipment (streamers) and the seabed has the potential to result in physical damage to benthic habitat and sensitive communities.

In the unlikely event contact occurs, localised physical disturbance of substrates, benthic habitats and communities may result.

Lost equipment has the potential to persist on the seabed as pollution/debris, leading to:

- potential entanglement with marine fauna
- potential entanglement with fishing gear (i.e. trawl nets);
- potential for localised smothering of, or physical damage to, sensitive benthic habitats;
- potential for fluid filled streamers to leach contents into the environment if streamers are ruptured and the fluid filling is exposed.

4.10.2.1 Potential Risks to Protected Habitats

Dragging of streamers along the seabed may occur in the event that a streamer becomes damaged and sinks to the sea floor while the vessel is in motion. Dragging of the streamer may result in localised physical disturbance of substrates, benthic habitats and communities. The operation al area does not include any sensitive benthic habitats and the coral reef habitats of the Ningaloo WHA are well outside the area of potential impact.

KEFs are described in Section 2.8. None of the KEFs within the operational are considered to be at significant risk of coming into contact with streamers during the MSS.

The highest risk is associated with acquisition within water depth of 30m in the southeast operational area. Streamers have a tow depth of 15 to 20 m and therefore there is a potential for streamers to be within 10 m of the seabed for a limited period of time in this area, especially on line turns.

Given the water depth range across the Operational Area (30 m to 1,500 m), the absence of any shallow waters (<20 m water depth) and any emergent features, the likelihood of an impact occurring is unlikely. Any consequences associated with loss of equipment would be minor, due to the low sensitivities of benthic habitats within the operational area. Inherent risk is Medium.

4.10.3 Control Measures and Measurements of Environmental Performance

Table 35 provides the control measures that SLB will implement during the activity to manage any potential risks associated with loss of equipment. All control measures from Revision 1 of the EP have been assessed, and where Schlumberger

considers that the sacrifice (in terms of time, cost and/or effort) is not grossly disproportionate to the environmental benefit gained, then those controls have been adopted for the activity.

4.10.4 Residual Risk

With the implementation of the control measures described in above, the likelihood of a risk being realised by all environmental receptors is reduced to unlikely, and residual risk of loss of equipment is Low. In accordance with the definition of a low residual risk within SLB's risk assessment matrix, the risk is therefore considered broadly acceptable.

Table 36: Control Measures and Environmental Performance Outcomes and Standards for Loss of Equipment

EPO: Avoid streamers impacting the seabed or benthic habitats			
Control Measure	**EPS**	**MC**	**Responsible**
Use of a solid streamer, rather than a fluid-filled streamer.	**EPS 110**: The MSS will be carried out using solid or gel-filled streamers.	Inventory list shows the streamer type being solid or gel-filled.	Vessel Party Chief
Pressure-activated, self-inflating buoys on streamers, designed to bring the equipment to the surface if lost accidentally during a survey.	**EPS 111**: The MSS will be carried out with pressure-activated, self-inflating buoys attached to streamer.	Activity inspection record confirm the pressure-activated, self-inflating buoys are on the cable	Vessel Party Chief
Streamer depth controlled using depth control units known as 'birds'. Wings on the birds enable steering (both vertically and horizontally) based on set parameters (i.e. pressure) to minimise the footprint in water and better manage the separation between each streamer being towed	**EPS 112**: Depth control units or 'birds' are attached to streamers to ensure the streamer depth is maintained between 15 and 20m depth along the entire length of the tow.	Inventory logs show birds are utilised. Acquisition data shows tow depth maintained between nominated depths.	Vessel Party Chief
Real time positioning of the streamers in 3 dimensions using Intrinsic Ranging by Modulated Acoustics (IRMA).	**EPS 113**: The MSS will be carried out using IRMA for positioning of the streamers.	Acquisition data shows the positioning of the streamers using IRMA data.	Vessel Party Chief
Adherence to vessel procedural documents for the deployment, operation and recovery of streamers	**EPS 114**: In water equipment is deployed and recovered in accordance with the vessels' equipment deployment and recovery plan.	Records or inspections show that the checklists verify vessels' equipment deployment and recovery plan has been complied with.	Vessel Master
SLB commits to recovering lost equipment where safe and practicable. Support vessels to assist in lost streamer / object recovery	**EPS 115**: Lost towed equipment will be relocated and recovered where safe and practicable to do in accordance with SLB Non Routine Equipment Recovery Procedure Reference: (ID 6291729).	Incident records	SLB Project Manager

4.11 Loss of Hazardous and Non-hazardous Substances

4.11.1 Description of Source of Risk

General non-hazardous and hazardous solid wastes will be generated during normal operations for the proposed Exmouth SLB15 MC3D MSS. Non-hazardous wastes may include scrap metal, packaging, wood, cardboard, paper, plastics and empty containers, which will be transferred onshore for recycling or disposal at registered facilities. Hazardous solid wastes that may be generated include paints and paint cans, oil contaminated materials (e.g. sorbents, filters and rags), batteries and fluorescent light tubes. These materials may be harmful to the marine environment if lost overboard. All material will be stored on board for the duration of the survey.

Non-hazardous and hazardous solid wastes may be released by accidentally dropping objects overboard (e.g. tools, streamer depth controllers) due to human error, equipment failure or adverse weather.

As part of normal seismic survey vessel operations, a range of chemicals and oily substances (such as lubricating oils and hydraulic fluid) will be stored on the deck of the survey and support vessels. Hydraulic fluid is also contained in reservoirs, hoses and lines on hydraulic equipment, such as cranes or winches. There is potential for accidental loss of these fluids through operator error or machinery malfunction. In the event of an accidental on-board spill of oily substances or chemicals (such as a containment leak), there is potential for the spill to be washed overboard and released into the marine environment.

Chemicals e.g. solvents and detergents will typically be stored in small containers of 5-25 L capacity and stored/ used in internal areas where any leak or spill would be retained onboard and cleaned up before any material enters the sea. Some spills may occur when small containers of chemicals are being used in open areas, where there is a risk of some entering the sea if spilled. The maximum chemical spill volume would be 25 L (largest capacity container) should a chemical spill in an unconfined area eventuate in release to the marine environment, a drum is compromised during handling or lost overboard during bad weather.

4.11.2 Known and Potential Risks

The known and potential environmental impacts from the loss of hazardous and non-hazardous solid wastes include:

- temporary localised decline in water and sediment quality
- localised toxicity to marine fauna if chemicals leak or leach from waste object
- potential injury to fauna if disposed overboard (e.g. ingestion of plastics)
- creating navigation hazards for other vessels if object floats.

4.11.2.1 Potential Impacts to Water Quality, Marine Habitats and Communities

Should accidental disposal of hazardous and non-hazardous materials occur, the potential impacts will be dependent upon the receiving environment and the nature of the lost object. Larger, heavier items could settle on the seabed, and cause localised disturbance to benthic communities.

Oily waste and chemical spills have the potential to impact the marine environment adversely if accidentally released in significant quantities. The potential impacts include a reduction in water quality and toxic effects on marine flora and fauna. In the event a loss to sea does occur, impacts to the marine environment would be minimal, due to the small potential volumes released, and the fact that spilt oil and chemicals will rapidly evaporate, disperse and weather. In the open ocean environment, spilled liquids would be rapidly dispersed and diluted to concentrations at which they are not harmful

4.11.2.2 Potential Impacts to Protected Area Values / Conservation Objectives

No highly sensitive habitats (e.g. coral reefs) have been identified within the operational area. The loss of small volumes of hazardous substances or non-hazardous would have a very localised impact on the marine environment. These localised and temporary effects would not compromise the values or conservation objectives of the Ningaloo WHA or other marine protected areas in the region.

4.11.2.3 Potential Impacts to Protected Species

Smaller items lost overboard, or larger items as they break down, may be ingested by mobile fauna such as turtles, whale sharks and cetaceans. However, the likelihood of this material being accidentally released is low and presents no greater risk than the other shipping which traverses the region.

The inter-nesting BIA for four species of marine turtles overlap a part of the Exmouth SLB15 MC3D MSS operational area. It is therefore possible that inter-nesting turtles may be encountered in the survey, particularly during peak nesting in December to February; however, it will likely be limited to individuals transiting through the Operational Area. Solid objects will tend to sink to the seabed and will therefore be unavailable for ingestion by pelagic fauna. Ingestion of marine debris has been identified as “of concern” for all marine turtles (Commonwealth of Australia 2012d). The internal structure of turtle throats prevents regurgitation of swallowed items, trapping them in the gut where organic wastes may decompose, leaking gases into the body cavity that cause the animal to float and ultimately die. White plastic debris (e.g. plastic bags) is of most concern to turtles who mistake it for jellyfish, a key prey item for some species (Derraik 2002).

Hazardous items may be mistakenly ingested and cause discomfort or adverse health effects for individuals. This would be limited to a small number of individual animals and small volumes of hazardous material; no lethal effects would be expected.

Water movement in the vicinity of the Exmouth SLB15 MC3D MSS operational area is driven by winds and tides. Release of small volumes of oily waste or chemicals would result in a localised adverse effect on water quality which would diminish as the waste is diluted and dispersed. Any effects to pelagic species would be extremely localised and temporary and are unlikely to have any impact on species diversity or abundance within the protected areas.

Non-hazardous solid waste such as plastics and aluminium could also become an entanglement hazard for avifauna, both to seabirds and shorebirds if the waste washes up on a beach. This can lead injury or strangulation and death.

4.11.2.4 Potential Impacts to Other Users

Large buoyant objects lost overboard may create a navigational hazard for other vessels operating in the area. This risk would be restricted to hard objects such as drums and pallets. Where possible and safe to do so, lost objects would be recovered by the support vessel.

4.11.3 Control Measures and Measurement of Environmental Performance

Table 37 provides the control measures that SLB will implement during the activity to manage any potential risks associated with loss of hazardous and non-hazardous waste. All control measures from Revision 1 of the EP have been assessed, and where Schlumberger considers that the sacrifice (in terms of time, cost and/or effort) is not grossly disproportionate to the environmental benefit gained, then those controls have been adopted for the activity.

4.11.4 Residual Risk

With the implementation of the control measures described in Table 37 above, the likelihood and consequence of the loss of hazardous and non-hazardous waste and other substances during the activity and these objects impacting upon environmental receptors is lowered to highly unlikely and slight (respectively) and the residual risk is Low. In accordance with the definition of a low residual risk within SLB’s risk assessment matrix, the risk is therefore considered ‘Acceptable’.

Table 37: Controls for Loss of Hazardous and Non-Hazardous Waste

EPO: No significant loss of solid non-hazardous/ hazardous waste overboard			
Control Measure	**EPS**	**MC**	**Responsible**
In compliance with Section 9 of the Protection of the Sea (Prevention of Pollution from Ships) Act 1983: All waste should be disposed of in an appropriate manner and not into the sea. All bins vessel decks should have a lid or cover to prevented garbage from going over the side. All waste receptacles should have labels. Recyclable material is to be separated from the main waste.	**EPS 116**: As per the Protection of the Sea (Prevention of Pollution from Ships) Act 1983, no waste (other than permissible discharges described in Section 4.5), shall be disposed into the sea.	Vessel audit or inspection.	Vessel Master
	EPS 117: As per the Protection of the Sea (Prevention of Pollution from Ships) Act 1983, vessel-specific waste receptacles on deck shall have lids or covers.	Vessel audit or inspection.	Vessel Master
	EPS 118: As per the Protection of the Sea (Prevention of Pollution from Ships) Act 1983, vessel-specific waste receptacles will be clearly labelled as to content.	Vessel audit or inspection.	Vessel Master
	EPS 119: As per the Protection of the Sea (Prevention of Pollution from Ships) Act 1983, recyclable waste shall be segregated from general waste on the vessel.	Vessel audit or inspection.	Vessel Master
In compliance with Marine Order 95 (Garbage), a Garbage Management Plan for management of waste is in place for vessels of an appropriate size and capacity.	**EPS 120**: As per MO 95 (Garbage) – Garbage Management Plan in accordance with guidelines developed by the International Maritime Organisation (IMO) is in place during survey.	Garbage Management Plan	Vessel Master
	EPS 121: The Garbage Management Plan (EPS 120) shall provide written procedures for collecting, storing, processing and disposing of waste, including the use of equipment on-board.		
In compliance with Marine Order 95 (Garbage), a record book is used to keep a log of waste, including when waste is discharged to the sea, when it is discharged to reception facilities ashore or to other ships, when it is incinerated, or any accidental or other exceptional discharges.	**EPS 122**: As per MO 95 (Garbage) – a Garbage Record Book is maintained and up to date for every ship of 400 gross tonnage and above, and every ship which is certified to carry 15 persons or more.	Vessel Garbage Record Books for relevant vessels.	Vessel Master

EPO: No significant loss of solid non-hazardous/ hazardous waste overboard			
Control Measure	**EPS**	**MC**	**Responsible**
Hazardous waste is separated and stored correctly to prevent contamination of other waste.	**EPS 123:** Hazardous substances are separated, labelled and stored onboard within secondary containment.	Vessel audit or inspection	Vessel Master
Material Safety Data Sheets for each hazardous substance will be available for instructions on management and disposal.	**EPS 124**: Material Safety Data Sheets (MSDS') shall be available at the place of storage for all chemicals on the vessel; and chemicals shall be managed in accordance with the MSDS as a minimum.	Vessel audit or inspection	Vessel Master
Notice to other marine users if navigation hazards created	**EPS 125:** Notice to mariners if large floating object lost to sea and non-recoverable	Record of notification to DoT re hazard	Vessel Master

4.12 Hydrocarbon spill

4.12.1 Description of Source of Risk

Loss of 561 m^3 of marine gas oil (MGO) to sea is considered the maximum credible scenario (MCS) as a result of a vessel collision (see Section 5.1). The risk of vessel collision is assessed in Section 4.3 (Interaction with other users), along with appropriate controls to reduce the risks to ALARP and an acceptable level. It is noted that no collisions, grounding or sinking of a seismic survey vessel or its support vessels has been recorded in Australian waters in at least the last 30 years, when the industry has been most active.

The ADIOS2 oil weathering model predicted that the spilled diesel would be either completely dispersed or evaporated within 36 hours. Under typical wind conditions at any time of year, the surface slick could travel up to 47 km in any direction. For the purposes of this EP risk assessment, a 50 km surface slick was assumed.

Maximum credible scenarios for a refuelling spill and for a deck fuel spill were estimated at 3.5 m^3 and 50 L respectively.

4.12.2 Known and Potential Risks to Environmental Receptors

The potential effects of a hydrocarbon spill on the marine environment varies greatly depending on factors such as the type of oil, weather and sea state at the time of release, response measures, and the sensitivities of the habitats and species potentially affected. Any release of MGO in the open ocean would be subject to rapid dispersal, weathering, evaporative losses and dispersion into the water column.

Potential impacts include physical oiling of marine fauna (including plankton, marine reptiles, marine mammals, sharks and rays, and seabirds) that are directly contacted by the surface slick. Secondary effects may include ingestion by seabirds after preening or through ingestion of oiled fish. A spill could also cause toxic effects to marine fauna within the sea surface layer due to bioavailable aromatic hydrocarbons, which dissolve into water from entrained droplets and floating oil. These aromatic hydrocarbons, including monocyclic aromatic hydrocarbons (MAHs) and low molecular weight polycyclic aromatic hydrocarbons (PAHs) can cause narcotic effects in fauna at high concentrations for extended periods.

Given the dispersive nature of MGO and the fact that the majority of species are highly mobile and avoidance behaviour is likely, significant impacts to marine fauna as a result of a hydrocarbon release are unlikely.

Benthic and shoreline habitats may be contacted by surface or entrained MGO if a spill occurs within the eastern limits of the operational area close to these sensitive receptors; and in the unlikely event that weather conditions direct the spill towards land within the timing windows described in Table 38.

The results of ADIOS2 modelling indicate that the majority of the hydrocarbons will have dispersed or evaporated in 15 to 18 hours. As MGO undergoes rapid dispersion and evaporation, concentrations reaching benthic and shoreline areas are predicted to be low, hence significant impacts are unlikely.

Table 38: Summary of ADIOS2 results

Hours into Spill	Evaporated %	Dispersed %	Remaining %
Summer			
1	0	0	100
4	2	5	93
8	8	32	60
12	15	61	24
18	18	78	3

Hours into Spill	Evaporated %	Dispersed %	Remaining %
22	18	80	1
26	19	81	0
Winter			
1	0	0	100
4	1	3	96
8	6	18	76
12	13	43	45
18	19	66	15
24	21	74	5
30	21	77	1
36	21	78	0

4.12.2.1 Potential Impacts to Marine Habitats and Communities

Coral reefs and shoals

Direct contract with surface and entrained hydrocarbons could lead to chemical toxicity, possibly leading to coral bleaching and colony death. Instead of acute mortality, it is more likely that hydrocarbon effects would be sub-lethal; resulting in reduced photosynthesis, growth or reproduction (NOAA, 2014). Surface hydrocarbon contact however would be limited to intertidal corals which will be periodically exposed to the surface hydrocarbons as well as planktonic stages of corals, in particular during periods of coral spawning. As MGO undergoes rapid dispersion and evaporation, concentrations reaching coral reefs are predicted to be low and significant impacts are unlikely. Contact with entrained hydrocarbons is possible, however rapid dispersion following entrainment from the surface would lead to rapid dilution and reduced toxicity and significant impacts are unlikely.

Seagrass and macroalgae

Intertidal macroalgae and seagrasses around coastal and offshore islands could be exposed to surface and entrained hydrocarbons. Impacts could include toxic effects from contact with PAHs within the oil or potentially a reduced capacity for photosynthesis. Given that MGO has a low persistence (<5%) and low inherent stickiness any contact would be expected to be short in duration and significant mortality is not expected.

4.12.2.2 Potential Impacts to Shoreline Habitats and Communities

Mangroves

Mangrove root systems (including pneumatophores) are sensitive to physical oiling. There is the potential for stands of mangroves on the mainland coast to be impacted by surface slicks of MGO and also potentially by accumulated stranded hydrocarbons. Given the low persistence, rapid dispersion and evaporation of MGO, contact with mangroves is unlikely. However, if contact occurred it would be expected to be at low concentrations and for short duration and significant impacts (mortality of trees) are not expected.

Intertidal mud and sand flats/ Rock shorelines and intertidal platforms

MGO has the potential to interfere with infaunal organisms that inhabit these areas either by modifying the habitat or smothering the feeding respiratory and/ or locomotory structures of these organisms. Hydrocarbons may contact the intertidal

shores as the tide ebbs, but it would be expected that this would be flushed with each flood tide. Natural flushing is more likely to reduce impacts in exposed areas of shoreline. As MGO also undergoes rapid dispersion and evaporation, concentrations reaching intertidal habitats are predicted to be low hence significant impacts are unlikely.

Sandy beaches

The accumulation of MGO on sandy beaches has the potential to impact marine fauna that utilise these beaches such as shore birds and turtles. The potential impacts on these sensitivities are discussed in the following sections.

4.12.2.3 Potential Impacts to Marine Fauna

Marine mammals

The regional area includes waters used by migrating humpback whales. The risk to humpback whales is greatest during the migrations season (June to October). Whales and dolphins could potentially ingest entrained oil when feeding in open water or become coated with MGO while surfacing to breathe. MGO has a low stickiness and MGO would wash-off the dorsal surfaces of cetaceans as they dive into deeper waters. There is the potential for volatile hydrocarbons to be inhaled if cetaceans were to surface within an MGO surface slick especially if this occurred close to the spill area where the hydrocarbons would be relatively fresh (i.e. have a greater concentration of volatile MAHs such as BTEX chemicals).

The highest potential risks for dugongs are related to direct ingestion of seagrass or macroalgae exposed to acute or chronic toxicity and or drastic reduction on seagrass coverage due to hydrocarbon spills (Heinsohn et al. 1977). Significant impacts to dugongs are unlikely as any coating of MGO droplets onto seagrasses would likely be temporary due to the low degree of stickiness and the low persistence (<5% of total mass) of MGO; also due to the rapid dispersion following entrainment from the surface.

Marine reptiles

Marine reptiles may come into contact with hydrocarbons in the event of a spill as they surface to breathe. In the unlikely event of hydrocarbon accumulation on turtle nesting beaches, the risk is for MGO to contact adult females during nesting seasons or turtle hatchlings 6 to 8 weeks following nesting. MGO is unlikely to stick to turtles in large amounts since it has a low stickiness and would likely wash off skin surfaces; however MGO may cause irritation to sensitive organs such as eyes. In terms of entrained MGO within shallow coastal waters, green and hawksbill turtles may be particularly sensitive since they feed in shallow water coral and macroalgae habitats and may ingest entrained diesel as well as potentially being contacted on external surfaces.

Sharks and rays

The most likely impact of entrained oil droplets on sharks and rays is through the pathways of ingestion or the coating of gill structures. This could lead to respiratory problems or accumulation of hydrocarbons in tissues. In the worst instance this could lead to mortality, or sub-lethal stress. As sharks and rays are highly mobile, avoidance behaviour is likely and significant impacts are not predicted.

Whale sharks are vulnerable during seasonal aggregations when they are observed swimming close to the surface, but otherwise remain away from surface for long periods and to depths beyond 700 m (DotE 2015e). Mako sharks are pelagic and tend to occur in waters less than 50 m deep, with occasional dives up to 640 m deep (Stevens et al, 2010). As such impacts are unlikely.

Seabirds and shorebirds

Seabirds may be contacted by floating MGO at a thickness that could create an impact if they were to feed or rest close to spill locations. The risk to shorebirds and coastal species would depend upon where surface oil accumulated; accumulation near nesting colonies or areas supporting feeding aggregations (i.e. sand/mud flats). Coating of feathers could occur for birds feeding or resting in surface waters or wading/roosting on oiled shorelines, although the low inherent stickiness and persistence of MGO makes this unlikely.

Oil-coated birds can suffer hypothermia, dehydration, drowning and starvation, and become easy prey. Ingestion of MGO could occur either through oil-coated birds preening feathers of birds feeding on MGO contaminated prey such as benthic invertebrates within mud/sand flats or pelagic fishes within surface waters. Toxicity from ingested MGO could occur as a result of toxic hydrocarbons such as PAHs present within weathered MGO. Given the dispersive nature of MGO and the fact that the majority of bird species are highly mobile, significant impacts as a result of an MGO spill are unlikely.

4.12.2.4 Potential Impacts to the Socio-economic Environment

Commercial fisheries

Temporary disruption to fishing activities may occur if the entrained or surface hydrocarbon plume moves through fishing areas. In the worst instance entrained oil could lead to loss of (or loss of function of) coastal intertidal habitat (e.g. seagrass meadows, mangrove communities, intertidal mudflats) which may provide nursery habitat for fishery species (e.g. fish and crustaceans).

Given the low persistence of MGO and low volumes that could be released, any significant loss of function is highly unlikely. Fisheries could also be impacted through the contact of oil droplets on fish/invertebrate gill structures, the ingestion of oil by target species and/or the potential for entrained oil to interfere with the development of fish eggs and larvae. Given the low persistence and low potential volume of MGO released there is a very low likelihood that this would have an impact on a fish population or fisheries scale. However interference to fishing operations may occur through damage to vessels and fishing gear, exclusion to areas during clean-up operations and any follow up monitoring and surveillance activities.

Aquaculture

Given that pearl oysters are filter feeders, entrained oil droplets could create negative impacts through ingestion and accumulation of hydrocarbon compounds in oyster tissues or interference with respiratory structures. Such impacts could lead to sub-lethal (e.g. reduced oyster growth rates, reduced reproductive success) or lethal effects. As MGO undergoes rapid evaporation and dispersion concentrations reaching aquaculture areas are predicted to be low and hence significant impacts are unlikely.

Tourism and recreation

In the event of a spill, entrained or floating hydrocarbons may cause temporary disruptions to tourism activities which could have a temporary impact on the tourism industry. Impacts to humans and tourism activities are not likely to be significant however there is the potential for temporary closure of recreational activities, including diving, due to risk to public health and safety. This would be short term and limited to the area immediately affected by a spill. Entrained hydrocarbons will naturally disperse and any shoreline accumulation would breakdown due to natural weathering processes. Therefore the potential for significant impacts to tourism is low.

Cultural heritage

It is unlikely that these ship wrecks will be contacted in by MGO concentrations high enough to cause detectable damage.

Shipping

The impact on shipping is the potential modification of shipping routes to avoid the area affected. These are not expected to be significant due to the expected rapid dispersion of MGO.

Petroleum Activities

A number of oil and gas operators operate in the NWS with existing projects and infrastructure in place as well as continuing drilling and exploration programs. A surface MGO spill has the potential to temporarily disrupt activity with associated economic impact. Such disruption is dependent on spills in relative close proximity to other operator activities. However, significant disruption is unlikely given the relatively short duration, and rapid dissipation of an MGO spill.

4.12.2.5 Potential Impacts to Protected Areas and Species

The values and sensitivities of threatened and migratory species and protected areas within the MCS area are described in Sections 2.3 and Section 2.8, respectively. The potential impacts to the species, habitats and socio-economic values are

described above (Sections 4.12.2.1 to 4.12.2.4). An oil spill could impact on the values and sensitivities of protected areas, however considering that it is highly unlikely that a vessel collision would occur (Section 4.3), and that if a spill did occur, the MGO would rapidly disperse and evaporate, no long term or severe impacts would be expected.

4.12.3 Control Measures and Measurement of Environmental Performance

Table 39 provides the control measures that SLB will implement during the activity to manage any potential risks associated with hydrocarbon spills. All control measures from Revision 1 of the EP have been assessed, and where Schlumberger considers that the sacrifice (in terms of time, cost and/or effort) is not grossly disproportionate to the environmental benefit gained, then those controls have been adopted for the activity.

4.12.4 Residual Risk

With the implementation of the control measures described in above, the likelihood and consequence of a hydrocarbon spill during the activity impacting upon environmental receptors is lowered to highly unlikely and minor (respectively) and the residual risk is Low. In accordance with the definition of a Low residual risk within SLB's risk assessment matrix, the risk is therefore considered 'Acceptable'.

Table 39: Controls for refuelling and hydrocarbon management

EPO: Avoid hydrocarbon spills			
Control Measure	**EPS**	**MC**	**Responsible**
Compliance with Marine Order 91 (Oil): ▪ An emergency plan for responding to hydrocarbon spill from the vessel is in place.	**EPS 126**: As per Marine Order 91 (Oil) - a Shipboard Oil Pollution Emergency Plan (SOPEP) or Shipboard Marine Pollution Emergency Plan (SMPEP) is in place and up to date, for any vessel of 400 gross tonnage and over. This will also apply to the chase vessels <400 GT.	Inspection, audit or other documented records indicates that the SOPEP or SMPEP is in place and up to date.	Vessel Master
If a hose gets caught and pulled the dry-break coupling will close and prevent loss of hydrocarbon.	**EPS 127**: Dry-break coupling will be used for all bunkering activities.	Refueling checklist includes use of dry-break couplings. Vessel audit or inspection confirms.	Vessel Master
Use floating transfer hoses to increase visibility of leaks	**EPS 128**: The bunkering hose is a floating type.	Refueling checklist includes use of floating transfer hose. Vessel audit or inspection confirms.	Vessel Master
Secondary containment measures are used to prevent hydrocarbon chemical spills going overboard	**EPS 129**: Hydrocarbon and chemical storage areas (e.g. engine room) are fully bunded and drain to the bilge water tank.	Vessel inspection verified that main deck and hydrocarbon and chemical storage areas are bunded.	Vessel Master
SLB commits to a buffer between refueling activities and the Ningaloo WHA to reduce the risk of spills impacting on its values.	**EPS 130**: SLB will not undertake refuelling activities within 40 km from the Ningaloo WHA.	Location of refueling operations from ships logs Vessel inspection / audit	Vessel Master
Deck drains are closed during refueling to direct any leaks on	**EPS 131**: Deck drains closed prior to fuel transfer.	Completed and signed bunkering	Vessel Master

EPO: Avoid hydrocarbon spills			
Control Measure	**EPS**	**MC**	**Responsible**
deck into the closed drains.		checklist prior to refueling.	
A vessel bunker checklist is completed for each fuel transfer, which ensures that the key mitigation controls are in place.	**EPS 132**: Vessel bunkering checklist must be completed.	Completed and signed bunkering checklist for each refueling operation.	Vessel Master
Maintenance of equipment to ensure it does not fail leading to a spill.	**EPS 133**: Hydrocarbon transfer hose is maintained in accordance with the PMS.	PMS entry of equipment inspection and maintenance.	Vessel Master
Bunds are maintained and inspected to ensure they retain their storage capacity	**EPS 134**: Bunded areas (fixed and portable) shall be maintained to retain their storage capacity, including following rainfall.	Vessel inspection / audit.	Vessel Master
Small spills on deck will be cleaned up using spill kits available onboard to prevent hydrocarbons going overboard.	**EPS 135**: Spill response kits are checked during scheduled SOPEP drills (Table 44) and following any incidents to ensure these are available in relevant locations, are fully stocked (to vessel class requirements) and used in the event of a spill to deck to prevent or minimise discharge overboard.	SOPEP drill records; or site inspection verifies that spill response kits are available in relevant locations and are fully stocked. Incident logs show use of spill equipment to control/clean up spills including records that show closed actions to replenish used equipment.	Vessel Master

4.13 Response to a hydrocarbon spill

4.13.1 Description of Source of Risk

In the event of a hydrocarbon spill a number of potential responses may be initiated dependent on advice from the Control Agency, the location and size of the spill, the potential for sensitive environmental features to be impacted, and the resources available (Table 40). These responses generally involve additional vessels and may involve field survey teams landing on beaches. Inappropriate responses may pose a risk to the affected environment.

Response actions will be based on a Net Environmental Benefit Analysis (NEBA) approach which considers the advantages and disadvantages of the different spill response options to determine if there would be a net environmental benefit resulting from the implementation of a particular response. NEBA takes into account the hydrocarbon type, the sensitivities of the regional area of the spill, and the potential impacts (positive and negative) of the proposed response strategy.

NEBA is used for preliminary assessment to determine the level of spill response required. In the actual event of a spill, the NEBA is revisited regularly as more information becomes available on actual conditions, spill trajectory path and locations of sensitive receptors. This review process allows response strategies to be adjusted to provide optimal results (refer to Section 5 for details of the OPEP).

Table 40: Assessment of applicable spill response strategies

Response strategy	Activity	Level 1	Level 2	Assessment
Source control	Securing cargo / trimming	✔	✔	In the event a vessel fuel tank is ruptured, or hydrocarbon storage spill occurs, cargo of the affected tank/storage containers is to be secured by means available. This may include via transfer to another storage area onboard the vessel; transfer to another vessel, or through pumping in water to affected tank to create a water cushion (tank water bottom). Trimming the vessel may also be used to avoid further damage to intact tanks. These actions will minimise the volume of fuel spilt.
Type I Operational Monitoring	Vessel surveillance	✔	✔	Surveillance actions are used to monitor and evaluate the dispersion of the spilled hydrocarbon, and to identify and report on any potential impacts to flora and fauna that may occur while the spill disperses. Surveillance results may also be used to assist in escalating or de-escalating response strategies as required. Vessel surveillance will be done for level 1 and level 2 spills using available vessels on scene for opportunistic surveillance operations. Priority for human safety will take place where a significant vessel casualty has occurred. Operational monitoring requirements to be assessed by relevant Control Agency.
	Aerial surveillance	X	X	Aerial surveillance is provided under the *National Plan for Maritime Environmental Emergencies* (Nation Plan) (AMSA 2014). SLB has plans to use a helicopter to effect monthly crew changes and provide Medevac cover during the MSS, however have not yet secured any terms and conditions for use. Helicopters will typically carry enough fuel to achieve the primary objectives of the flight and this is not expected to be a resource that can be counted on in an emergency for management of non-safety related issues.

Response strategy	Activity	Level 1	Level 2	Assessment
	Trajectory Modelling	X	X	The National Plan provides arrangements for oil spill trajectory modelling to be implemented by AMSA. SLB will provide the spill details needed for this action to occur through submission of via the POLREP form contained in the SOPEP. SITREP forms will be provided to AMSA as the situation continues to be monitored.
Chemical dispersion	Enhance the dispersion rates of hydrocarbon into marine waters	X	X	MGO is not considered a persistent hydrocarbon, and has high natural dispersion rates in the marine environment. Chemical dispersant application is not recommended as a beneficial option for MGO as it has a low probability of increasing the dispersal rate of the spill while introducing more chemicals to the marine environment.
Containment and recovery	Booms and skimming	X	X	Given the fast spreading nature of MGO causing the slick to break up and disperse, this response is not considered to be effective in reducing the net environmental impacts of an MGO spill. The ability to contain and recover spreading MGO on the ocean water surface is extremely limited due the very low viscosity of the fuel.
Mechanical dispersion	Vessel prop-washing	X	X	MGO is highly evaporative. Vessel prop washing promotes entrainment and prevents evaporation, thus keeping the substance in the water for longer periods. The primary method for response is to monitor the evaporation and dispersion of the spill. Though this option is reserved for consideration if requested by the control agency dependent on the location of the spill and NEBA.
Protection and deflection	Deflection and protection booms	X	X	Given that MGO is not expected to be persistent and that corralling of these is not generally effective, tidal flushing and bioremediation is expected to be sufficient in the worst case scenarios to prevent any significant environmental impact.
Shoreline clean-up	Physical removal, surf washing, flushing, bioremediation, natural dispersion	X	X	Intrusive response that requires careful site specific planning in order to reduce secondary impacts of beach erosion and spreading oil beyond shorelines are not preferred for MGO. This response has potential to cause more harm due to secondary disturbance compared to the initial potential light oiling. So if light shoreline contact occurs, SLB considers that any onshore response options would best occur under transitional arrangements available through the National Plan (AMSA 2014).
Oiled wildlife response	Vessel-based Hazing	X	X	Undertaking this activity has the potential to result in more harm if poorly executed (i.e. drive marine animals into spill or split up the pods, schools, and flocks resulting in further stresses). SLB will not undertake hazing. Given the low likelihood of a spill of this size presenting a significant risk of oiling wildlife, SLB does not consider it to be reasonable for an activity specific oiled wildlife plan to be developed and for key SLB personnel to be trained and available on support vessels to undertaken hazing activities. The control agency may still consider this response dependent on the location of the spill and NEBA. That is, hazing will only occur at

Response strategy	Activity	Level 1	Level 2	Assessment
				the direction of, and under direct supervision of trained personal from the Control Agency and where hazing is determined to result in net benefit. In this instance, dependent on the operational situation, SLBs role will consider use of vessels of opportunity to assist the control agency with this response.
	Capture and rehabilitation	X	X	There are arrangement for oiled wildlife under the National Plan in the unlikely event this is required.
Type II Monitoring	Monitor sensitivities at risk	X	✔	Extent/impact of spill to determine the extent of Type II monitoring (refer to section 5.4.2).

4.13.2 Known and Potential Risks to Environmental Receptors

The additional activities associated with a hydrocarbon spill response introduce additional risks to marine fauna and habitats, as well as increasing the likelihood of many of the impacts and risks described in this EP.

4.13.3 Control Measures and Measurement of Environmental Performance

Table 41 provides the control measures that SLB will implement during the activity to manage any potential risks associated with a hydrocarbon spill response. All control measures previously presented in Revision 1 of this EP have been assessed, and where SLB considers that the environmental benefit gained outweighs the sacrifice (in terms of time, cost and/or effort), then Revision 1 controls have been carried through into this Revision 2 of the EP and will be adopted during the activity.

Note that SLB will commit to Type I monitoring using vessels of opportunity when safe to do so and where the NEBA as agreed with the Control Agency shows there is a net benefit in doing so. SLB will commit to Type II monitoring, in consultation with the control agency; dependent on the spill circumstances and sensitivities at risk. SLB does not consider that it is reasonable to undertake pre-activity monitoring or develop a detailed Type II monitoring plan prior to the activity based on the level of spill risks presented Section 5.4.

4.13.4 Residual Risk

With the implementation of the control measures described in Table 41 above, the likelihood and consequence of a hydrocarbon spill response during the activity impacting upon environmental receptors is lowered to unlikely and slight (respectively) and the residual risk is Low. In accordance with the definition of a low residual risk within SLB's risk assessment matrix, the risk is therefore considered 'Acceptable'.

Table 41: Controls for management of responses to a hydrocarbon spill

EPO: Avoid secondary impacts as a result of spill response.			
Control Measures	**EPS**	**MC**	**Responsible**
The SOPEP/SMPEP will be implemented for first strike response to level 1 and level 2 spills.	**EPS 136**: In the event of a hydrocarbon spill, the vessel master will Implement available controls and resources of the SOPEP/SMPEP.	Incident Report	Vessel Master
NEBA to be conducted prior to response actions.	**EPS 137**: Response actions will be based on a Net Environmental Benefit Analysis (NEBA) approach which considers the advantages and disadvantages of the different spill response options to determine if there would be a net environmental benefit resulting from the implementation of a particular response.	NEBA report	Vessel Master
SOPEP/SMPEP will outline source control measures to be implemented in the event of a vessel collision and subsequent spill	**EPS 138**: The Vessel Master will implement the SOPEP (EPS 126) source control measures in the event of a vessel collision and subsequent spill.	Valid SOPEP	Vessel Master
A hydrocarbon spill will be immediately reported to SLB Perth to ensure all notifications are provided as per Section 5.	**EPS 139**: The vessel Master is responsible to undertake the initial SOPEP/SMPEP reporting requirements and will immediately report to SLB Perth.	Phone/ email records	Vessel master
	EPS 140: External notifications in the event of a level 1 or level 2 spills will be carried out as per Section 5.	Consultation records	SLB Project Manager
Type I Operational monitoring will be undertaken to inform the control agency about the behaviour likely trajectory and key sensitivities at risk from a spill	**EPS 141**: Support vessels undertaking the MSS are used as vessels of opportunity to monitor the spill if safe to do so and where NEBA identifies a net benefit to do so (as agreed with Control Agency).	Incident Report/ Consultation records NEBA Report	Vessel master
Type II Scientific Monitoring may be required in the event of the highly unlikely scenario where key protected sensitivities are impacted by an oil spill. At the time of preparing this EP, SLB has no arrangements in place for Type II monitoring capability. However, given the proximity to the Ningaloo WHA and possible shoreline contact described, SLB has considered that it is reasonable for arrangements to be 'at the ready'; in the unlikely event this is needed or requested by the controls agency during a spill.	**EPS 142**: Prior to the commencement of the Exmouth SLB15 MC3D MSS, SLB will secure services (signed contract) with a third party for standby services to undertake Type II scientific monitoring in the unlikely event that an oil spill results in impacts to protected matters.	Service contract in place prior to commencement of the Exmouth SLB15 MC3D MSS	SLB Project Manager
	EPS 143: The contract described in EPS 142 will be with a service provided with Industry recognised qualifications in Type II monitoring.		
	EPS 144: The contract described in EPS 142 will describe standby arrangement including ability to respond within 2 hour of notification of a spill to commence planning and mobilisation arrangements (if required).		

EPO: Avoid secondary impacts as a result of spill response.			
Control Measures	**EPS**	**MC**	**Responsible**
	EPS 145: The contract described in EPS 142 will only be executed where the control agency request these services in responding to the spill; when safe to do so; and where NEBA demonstrates a net benefit of doing so.		
Oil spill response training and competencies are to be maintained to avoid unplanned environmental impacts due to human error	**EPS 146**: An oil spill response drill will be undertaken in accordance with SOPEP requirements on all vessels prior to conducting the activity (within 3 months prior) and will be in accordance with testing requirements (including frequency) of the response arrangements described in Table 44.	Drill records as per MARPOL Annex I (Regulation 15) requirements.	Vessel master

4.14 Environment Performance Monitoring

4.14.1 Monitoring and record keeping

SLB will maintain a quantitative record of emissions and discharges as required under Regulation 14(7) of the OPGGS(E). This record will include emissions and discharges to the air and water that can be monitored and audited (Section 4.14.2) against the environmental performance.

Each vessel will prepare a daily report and carry out a weekly inspection. The weekly inspection checklist will be included in the end-of-week daily report. Reporting/inspection will ensure:

- Environment issues/concerns raised through the MoC process are communicated to SLB management and recorded for future learnings;
- Any issues arising from SOPEP testing are reported;
- Monitoring of key parameters (Table 42) is recorded including an evaluation of environment performance (Section 4.14.4);
- Results will be reported in the end-of-survey EP performance report submitted to NOPSEMA
- The performance of key equipment (i.e. oil in water separator, maintenance in accordance with PMS) is checked at least weekly to ensure ongoing reduction of risks and impacts to ALARP, and any potential issues (i.e. observations of poor operating condition/performance or non-conformances) are continually monitored and raised as soon as practicable.

SLB will store and maintain documents or records relevant to the EP implementation for a period of five years.

Table 42 summarises the routine environmental monitoring requirements for the proposed survey activities.

Table 42: Summary of routine environmental monitoring

Aspect	Parameter Measured	Reporting to be maintained
Introduced Marine Pests	Volume of ballast water and date of discharge is recorded	Weekly checklist confirms that ballast records maintained in accordance with BWMS.
Interaction with marine megafauna	Marine megafauna observations	Daily report summarises any adaptive measures that needed to be applied due to marine fauna. Weekly checklist confirms that Marine Fauna Sighting Datasheets are correctly filled out and maintained.
Hazardous and non-hazardous solid waste	Volumes of waste generated.	Weekly inspection record confirms waste tracking certificates or garbage record books are up to date.
Atmospheric emissions	Fuel used by vessels is recorded	Weekly inspection record of volume of MGO used.
Refuelling	MGO volume	The daily record will record the day of bunkering and provide sufficient details to confirm: ▪ A bunker note/record maintained. ▪ Refuelling checklist completed. ▪ No incidents during refuelling.
Grey water and sewage	Quantity, time and location of sewage discharged	Weekly inspection record confirms that recordable discharge records are maintained.

4.14.2 Marine fauna observation reporting

A record of marine fauna interaction procedures employed during operations will be maintained. The MFO Final Report on the conduct of the survey, and any marine fauna sightings/interactions (including any whale-instigated shut-downs of the acoustic source) will be provided to DotE within two months of the completion of the survey. The report will contain:

- the location, date and start-up time of the survey;
- name, qualifications and experience of any MFO involved in the survey;
- the location / times / reasons when observations were hampered by poor visibility or high winds;
- the location and time any start-up delays, power downs or stop work procedures instigated as a result of whale sightings;
- the location, time and distance of any cetacean, whale shark and turtle sightings; and
- the date and time of completion of the survey.

The following procedures will be implemented during the survey to ensure all marine fauna sightings are properly recorded and reported:

- detailed reports of all cetacean sightings will be recorded using the DotE Cetacean Sightings Application (CSA - Version 3 - BETA) (http://data.marinemammals.gov.au/portal/csa/); and
- at the completion of the survey, a copy of the report generated by the CSA will be provided to DotE as part of the MFO Final Report.

4.14.3 Auditing

SLB assesses operating performance to ensure that the processes and systems adopted are effective in meeting the QHSE policy and IMS standards. HSE performance on the vessel is monitored and reported on a daily basis for feedback to SLB management, and where required, regulatory authorities.

HSE performance is discussed at all daily management meetings and daily HSE meetings for offshore crew. The Auditing Standard (SLB-QHSE-S007) details how audits are scheduled and executed, and will be implemented to ensure that compliance with the EP environment performance is assessed.

An audit against the requirements of the EP and SLB Environmental Standard (SLB-QHSE-S008) must be conducted within two months of commencing operations. The SLB Onboard Representative will continually inspect requirements of the EP onboard the vessel as part of daily activities.

4.14.4 Management of non-conformance

All breaches of the EP are considered non-compliances. All EP non-compliance issues must be communicated immediately to appropriate offshore and onshore management personnel. This expectation will be reinforced at inductions and regular HSE management and crew meetings.

Non-compliances may be identified during an inspection, audit, and routine crew observation or as a consequence of an incident. Where non-compliance is identified, remedial actions will be developed to prevent recurrence and tracked to completion.

Follow-up actions will be recommended, recorded, communicated to affected parties and remedial actions implemented and tracked to closure in accordance with the Reports of Non-Conformities, Accidents, Incidents and Hazardous Occurrences Procedure (M3ISM/P015).

4.14.5 Review of the EP

Changes in the risk profile of the activity will be assessed in the context of the OPGGS(E) Regulation 17 regarding the need to submit a revised EP due to significant changes in the level of risk.

Reviews of the EP (including OPEP) will be conducted to:

- ensure all significant environmental aspects of the activity are covered in the EP;
- ensure that environmental management measures to achieve EPO and EPS are being implemented, reviewed and where necessary amended;
- any change to the EP is managed through SLBs MoC procedure; and
- identify potential non-conformances and opportunities for continuous improvement;

SLB will review the EP, including:

- Partial review of a specific area of the EP relating to a specific aspect/concern or issue (if required) or;
- Detailed review as required through MoC process based on concerns/issues raised or proposed changes; or
- Complete review following each of the campaigns or' at least within 12 months from the date the last review.

5 Oil Pollution Emergency Plan

5.1 Nature and Scale of preparedness

The Maximum Credible Scenario (MCS) is a spill of 561 m^3 of MGO (diesel) from a vessel collision resulting in rupture and loss of the vessel's largest fuel tank. The closest part of the operational area to nearshore habitats is ~5.8 km to the Muiron Islands and ~13.3 km to North West Cape. The worst case is if the spill occurs at the boundary of the operational area and the spill is directed straight towards the shoreline, this could result in a minimum time to shoreline contact of <1 hours.

5.2 Shipboard Oil Pollution Emergency Plan

As required under MARPOL 73/78 Annex I (Regulation 37), all ships greater than 400 gross tonnes must carry an oil spill prevention plan, a SOPEP, as required by the IMO. The SOPEP recognises the divisions of responsibility as defined under National Plan (ASMA 2014) to provide effective response to marine pollution

Each vessel will have an IMO certified SOPEP; a SOPEP drill will be conducted prior to the activity (within 3 months) and at least every 3 months during the activity; the spill kits will be fully stocked (to vessel class requirements). In the event of a hydrocarbon spill, the vessel master will immediately implement the controls and resources of the SOPEP.

5.3 Oil spill response framework

SLB uses the incident classification as outlined in the National Plan (ASMA 2014) for hydrocarbon spills to provide direction on the potential consequence and impact of the incident and to provide guidance for preparedness, incident notifications and response actions.

SLB recognises two levels of incident are possible:

- Level 1 Incidents are generally able to be resolved through the application of local or initial resources only (e.g. first-strike capacity); and
- Level 2 Incidents are more complex in size, duration, resource management and risk and may require deployment of jurisdiction resources beyond the initial response.

The division of the responsibilities in the event of a hydrocarbon spill that affects State or Commonwealth Waters is provided in Table 43.

Table 43: State and Commonwealth Oil Spill Responsibilities

Location of Incident	Spill Source or Location	Statutory Authority2	Control Agency3	
			Level 1	Level 2
Commonwealth waters	Shipping sourced spill	NOPSEMA	AMSA	AMSA
State waters		WA DoT	WA DoT	WA DoT

2 Statutory Authority- The agency having the statutory authority in the area where a particular pollution incident occurs. Primarily responsible for ensuring an appropriate and adequate response is mounted by the Control Agency

3 Control Agency - The agency identified as being primarily responsible for responding to a particular incident

5.3.1 Control agency

If a ship-sourced hydrocarbon spill occurs within Commonwealth waters, AMSA is the designated Control Agency and will assume control of the incident and respond in accordance with the National Plan.

SLB will assume a Support Agency role and provide all available support to AMSA in AMSA's performance of their Control Agency responsibilities.

5.3.2 State waters transitional arrangement

The aim of the WESTPLAN – MOP (State Emergency Management Plan for Marine Oil Pollution) is to detail the management arrangements for preparation and response to a MOP incident in order to minimise the effects of oil pollution incidents occurring in State Waters.

WESTPLAN – MOP (DoT 2015) outlines the requirements for jurisdictions to maintain sufficient stocks of response equipment to manage an oil spill incident within their jurisdiction based on their current risk assessment and oil spill contingency plan. The composition and location of these stockpiles should be based on an assessment of the risk for that jurisdiction.

Maritime environmental emergencies have the potential to impact upon the interests of two or more Australian jurisdictions, where both jurisdictions have legitimate administrative and regulatory interests in the incident. The National Plan addresses the complexities of such incidents through the Guideline on the Coordination of Multiple Jurisdiction Incidents. This procedure provides for:

- establishment of an incident coordination process
- determination of a 'lead' jurisdiction, if appropriate.

5.3.3 Testing of the OPEP

SLB will maintain a state of preparedness to respond to an oil spill emergency and regularly test that the response arrangements are current and effective. A summary of arrangements for testing the response arrangements is provided in Table 44.

Table 44: Testing requirements of the response arrangements

OPGGS(E)Requirements	Description
As per Regulation 14(8B) of the OPGGS(E)R 2009, the arrangements for testing the response arrangements must include:	
A statement of the objectives of testing	Testing provides an opportunity for crew to gain confidence in using onboard spill equipment and implementing incident response procedures, increase efficiency in the event of an emergency, review the efficiency of procedures and detect any failures in equipment.
A proposed schedule of tests	Regular drills and exercises (three monthly) are carried out on all vessels in line with IMO/SOPEP. These drills include, but are not limited to, spill response, collision and grounding, fire and explosion and helicopter emergency.
Mechanisms to examine the effectiveness of response arrangements against the objectives of testing	▪ Issues raised (if any) will be described in daily report. ▪ Weekly checklist ensures that spill monitoring equipment is in place and fully stocked. ▪ Requirements described for the review of the EP and OPEP; and ▪ Requirements described for testing below.
Mechanisms to address recommendations arising from tests	Issues raised (if any) resulting from testing will be described in daily report. The Vessel Master is made aware that the change is managed to this OPEP and the EP through MoC .

OPGGS(E)Requirements	Description
As per Regulation 14(8C) of the OPGGS(E)R 2009, the proposed schedule of tests provides for the following:	
Testing the response arrangements when they are introduced	A SOPEP drill onboard all vessels will be carried out prior to the commencement of the activity and 3 monthly thereafter.
Testing the response arrangements when they are significantly amended	Any changes to the OPEP or EP will be introduced through the MoC. Where changes reasonably affect the arrangements in place, the changed arrangements will be tested prior to finalising the MoC.
Testing the response arrangements not later than 12 months after the most recent test.	Testing will occur every 3 months as described above.
If a new location for the activity is added to the environment plan after the response arrangements have been tested, and before the next test is conducted—testing the response arrangements in relation to the new location as soon as practicable after it is added to the plan	No activity will occur outside the operational area.
If a facility becomes operational after the response arrangements have been tested and before the next test is conducted—testing the response arrangements in relation to the facility when it becomes operational	Not applicable

5.4 Monitoring of oil spill impacts

5.4.1 Type I Operational Monitoring

Type I "Operational Monitoring" will be implemented where safe to do so, and where NEBA identifies there is a net benefit in doing so (as agreed with Control Agency), this monitoring will be implemented to:

- determine the extent and character of a spill;
- track the movement/ trajectory of surface diesel slicks;
- identify areas/ resources potentially affected by surface slicks; and
- determine sea conditions/ other constraints.

This monitoring will enable the Vessel Master to provide the necessary information to the relevant Control Agency (AMSA or WA DoT), via a POLREP form, to determine and plan appropriate response actions under National Plan and WESTPLAN - MOP. Operational monitoring and observation in the event of a spill will inform an adaptive spill response and scientific monitoring of relevant key sensitive receptors.

Ongoing situational awareness information is provided to the Control Agency through the use of a Marine Pollution Situation Report (SITREP).

5.4.2 Type II Scientific Monitoring

SLB will undertake Type II monitoring, as required in consultation with the Control Agency; dependent on the spill circumstances and sensitivities at risk. SLB recognises the potential for shoreline contact and the values and sensitivities that

are present within the Ningaloo WHA and the need to be able to respond rapidly to assess the extent of any impacts. Therefore SLB will establish a service agreement with a spill response service provider prior to the commencement of the Exmouth SLB15 MC3D MSS. This will ensure SLB has a capability to undertake Type II monitoring if required at short notice. The service agreement will enable the chosen service provider to respond rapidly (in a capacity as agreed with all parties), to either assist the Control Agency or to undertake key Type II monitoring activities on SLBs behalf (if initiation criteria are triggered).

5.4.2.1 Situational Awareness

In the event of a spill, details that will be exchanged between SLB and the service provider describing situational awareness will include:

- Hydrocarbon type and size of spill;
- Is the spill under control;
- Potential environmental or external influences that may impact a monitoring response;
- Predicted behaviour and predicted trajectory of the spill;
- Potential sensitivities at risk;
- Any ongoing safety concerns.

5.4.2.2 Protection priorities

In the event of a hydrocarbon spill, Table 45 summarises the priorities for protection and monitoring. It must be noted that a diesel spill will rapidly dissipate and there will be little value in trying to recover spilled fuel; rather the focus will be on monitoring the potential impacts of the spill, as requested by the Combat Agency.

Table 45: Protection and monitoring priorities

Priorities		Values and Sensitivities
Habitat and cultural resources		
Shorelines/ Nearshore	Mangroves	Important habitat for birds, molluscs, crustaceans, juvenile fish; bird watching hide. Significant mangrove habitats are found in the Exmouth Gulf. Mangroves are highly susceptible to oil exposure; lighter oils such as marine diesel are more acutely toxic to mangroves than are heavier oils (increased weathering generally lowers oil toxicity).
	Coral reefs	Important habitat for fish, crustaceans, sponges and molluscs. Significant coral reefs are found in Ningaloo Direct contact with surface oils could lead to chemical toxicity across cellular structure leading to coral bleaching and colony death.
	Macroalgae and seagrass	Important primary producers and support diverse and abundant fauna of small invertebrates that are the principal food source for many inshore fish species. Macroalgae are found in depths <25 m. Seagrasses usually grow on mud, sand or coral sand from the intertidal zone to approximately 50 m water depth, and are most prolific in 2 m to 10 m depth
	Sandy beaches	Social amenity; shorebird foraging/ breeding habitat; turtle nesting habitat. Limited beach access for users while oiled; oiled sandy/ mud flats in the intertidal may lead to a loss of infauna and ingestion of oil/ oiling of shorebirds; adult female turtles accessing nesting

Priorities		Values and Sensitivities
		beaches may be oiled in the surf zone and on the beach; emergent hatchlings entering nearshore waters may be oiled crossing the beach and then completely emerged in surface slicks.
Endangered flora and fauna		
Submerged/ Offshore	Whale sharks	Direct effects of a hydrocarbon spill on whale sharks may include contact of surface or entrained oil or ingestion of entrained oil during feeding if they were present in the region at the time of the spill. Indirect effects may occur if whale shark food supplies are affected by an oil spill. Whale sharks are filter feeders, relying predominantly on plankton and less frequently, small fish and invertebrates. The effects of hydrocarbons on plankton are likely to be of short duration due to their broad spatial movements and rapid reproductive strategies. Whale shark diets may also include coral spawn, however it is undetermined whether coral spawn accounts for a significant proportion.
	Cetaceans	May be potentially affected by direct contact with oil or oil ingestion
	Pelagic and demersal fisheries	Exposure to dissolved hydrocarbons and naturally dispersed oil in the water column. Toxic effects of ingesting tainted food or suffocation caused by clogging of the gills. Fish eggs and larvae are sensitive to toxic effects.
	Sea birds	Diving into the water to feed may be result in oil ingestion and damage to plumage potentially resulting in hypothermia
Shoreline/ Nearshore	Turtles	May be potentially affected by direct oil ingestion, contamination of the food supply or by absorption through the skin; susceptible to eye infections.
	Shorebirds	Oiling of birds at the surface from slicks and oil-affected foreshores. Contamination of their food source and oil plumage while foraging.
Commercial resources		
Shoreline/ Nearshore	Fisheries and Aquaculture	Important economic resource; reduced demand for fish from areas affected by an oil spill resulting in economic loss to fishing communities.
Offshore	Petroleum operators and shipping	A vessel collision and hydrocarbon spill within a shipping fairway of nearby offshore assets could result short term disruption or cessation of operational activities.
Amenities		
Submerged/ Offshore	Recreational fishing	Important for tourism; loss of reputation for fishery due to community concerns about fish tainting.
	Recreational diving with/ viewing of Whale Sharks	Important for tourism from March to July; loss of tourism in surrounding area.
Shoreline/ Nearshore	Sandy beaches	Important for tourism; loss of tourism in surrounding area.

5.4.3 Scientific monitoring programs

The rationale behind including each type of scientific monitoring program is provided in

Table 46. Some of the environmental receptors described in the EP are not specifically included in the nominated monitoring plans due to impracticality of such monitoring. For example, impacts to cetaceans and whale sharks at risk resulting from the MCS would be extremely difficult to evaluate given the short duration of the spill and inability to rapidly identify and sample potentially impacted individuals. However, scientific monitoring programs will remain adaptive, such that they can be focussed on key sensitivities at risk and additional receptors can be added on reasonable request of the Control Agency.

Table 46: Scientific monitoring program rationale

Program	Rationale
Marine water quality	Reduced water quality is likely to result due to entrained and dissolved aromatic hydrocarbons. Water quality is important for understanding the level of impact (i.e. contaminant concentration and duration) to a receptor and these details are vital for supporting other evaluation undertaken for other monitoring programs described
Intertidal and shoreline sediment quality	Hydrocarbons contaminants can be persistent in and on the sediment. This can lead to shoreline and intertidal biota to be exposed to chronic toxicity levels of hydrocarbons.
Nearshore coral, seagrass and macroalgae communities	Sub-lethal effects on corals (including increased mucus production, bleaching), macroalgae (reduced coverage and/or diversity) and seagrasses (reduced extent and density) may occur if the concentration and duration of exposure are above toxicity levels to these benthic organisms.
Mangroves	Mangrove health may be adversely affected due to increased concentration of hydrocarbons in sediments and coating due to floating oil.
Intertidal and shoreline habitats	Shoreline habitats including rocky shorelines, intertidal platforms and sandy beaches may be contacted by stranded floating oil or entrained droplets. Oil can become increasingly entrained within the nearshore waters. The elevated levels of hydrocarbon can lead to exposure of aquatic organisms to toxic components of the hydrocarbon above threshold levels leading to impacts on the organisms.
Seabirds and shorebirds	Impacts to seabirds and shorebirds due to presence of surface, entrained and dissolved aromatic hydrocarbons may include behavioural (e.g. deviation from migratory routes), physiological (e.g. disruption to digestion) and/or physical (e.g. matting of feathers, inability to fly).
Feeding, nesting and hatching sea turtles	Impacts to sea turtle due to presence of surface, entrained and dissolved aromatic hydrocarbons may include behavioural (e.g. deviation from migratory routes), physiological (e.g. disruption to digestion) and/or physical effects such as direct oil coating on shorelines.
Socio economic impact monitoring.	Impacts to fish, shellfish and aquaculture due to presence of entrained hydrocarbons may include lethal and sub-lethal physiological effects (e.g. reduced growth) and physical effects (e.g. fin erosion). Exposure of commercial and recreational target species to dissolved aromatics can cause flesh tainting and levels of toxicants above human consumption guidelines. Disruption to tourism and regional economies may also be possible due to perceived negative effects on natural environment.

6 Details of the Titleholder's Nominated Liaison Person for the Activity

The title holder's nominated liaison person is described in Table 47.

Table 47: Titleholder's nominated liaison person details

OPGGS(E)R 2009 Requirements	Description
a) name	Tristan Allen
b) business address	Level 5, 256 St Georges Terrace, Perth WA 6000
c) telephone number	+ 61 8 9420 4801
d) fax number	+ 61 8 9322 3080
e) email address	environment@slb.com

NOPSEMA will be notified according to the requirements of Regulation 15(3) of the OPGGS(E) Regulations of changes to the title holder, the nominated liaison person, or contact details for either the title holder or liaison. SLB will submit written notice of changes to NOPSEMA within 30 days of the change.